OCTOBER 1960

Power Engineering

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This brine tank never needs cleaning out

With 100% soluble Morton Purex Salt you never have an accumulation of insolubles: no encrustation, no sediment buildup in brine storage chambers. For Purex Salt is guaranteed to have both a minimum purity of 99.5% sodium chloride and to be free of insoluble matter than can settle out in brinemaking systems. You'll find Purex ideal for producing a fully saturated, high clarity brine at highest possible flow rates.

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Available in bags and bulk carloads. Purex can be used in bulk wet storage systems and in Morton Model E Series Brinemakers.

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Beat Heat Fatigue by taking Morton Yellow Salt Tablets. They give fast relief without causing nausea or stomach upset. Available with heavy duty disposable dispensers.

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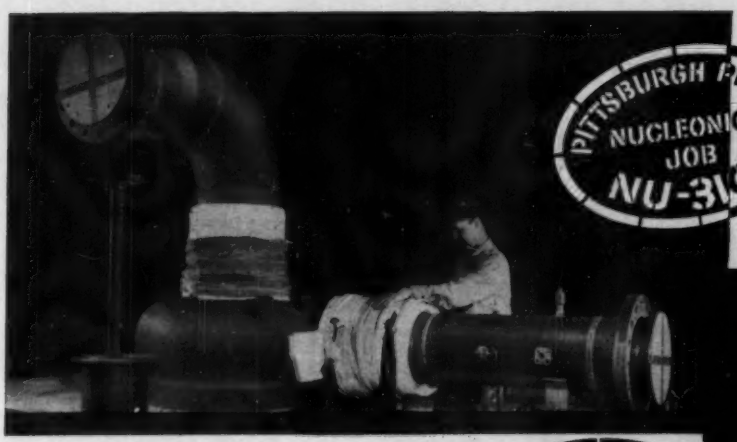
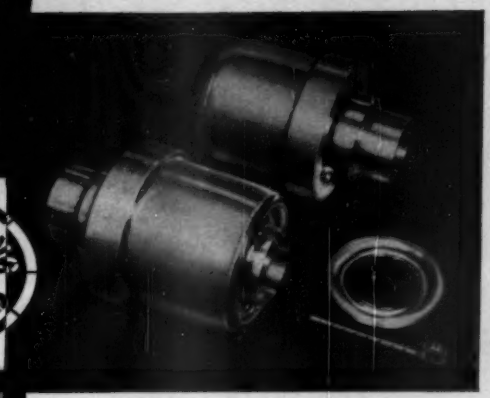
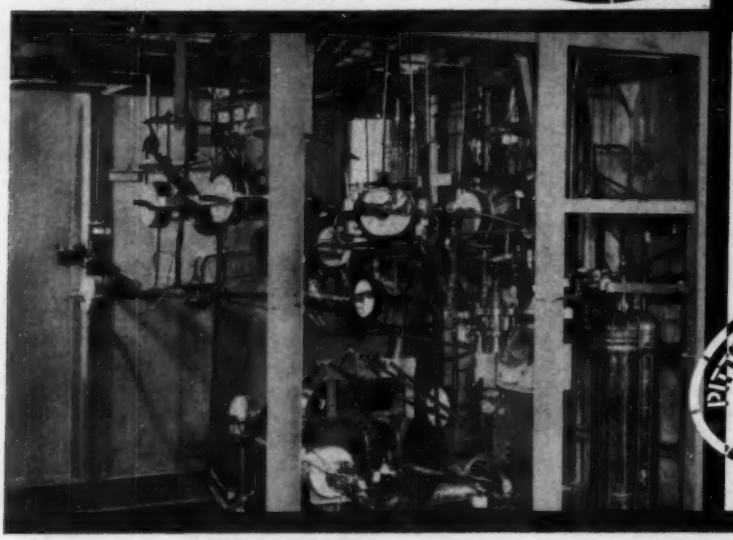


VOLUTE ASSEMBLY



BULKHEAD PENETRATOR



STAINLESS STEEL LOOP

Fabricated by Pittsburgh Piping for Nucleonics

These jobs demonstrate the variety of nucleonic piping work done in our shops. The volute assembly, shown in intermediate stage of manufacture, is fabricated of 14" and 16" Schedule 160 piping materials. The bulkhead penetrator, one of a group, is notable for an unusual method of welding dissimilar metals. The complex test loop requires skillful welding of stainless steel piping materials, and precise assembly of hundreds of components. We are equipped and staffed to do similar jobs for you. Telephone, or write and our representative will call. Or, we will be glad to have you visit our plant.

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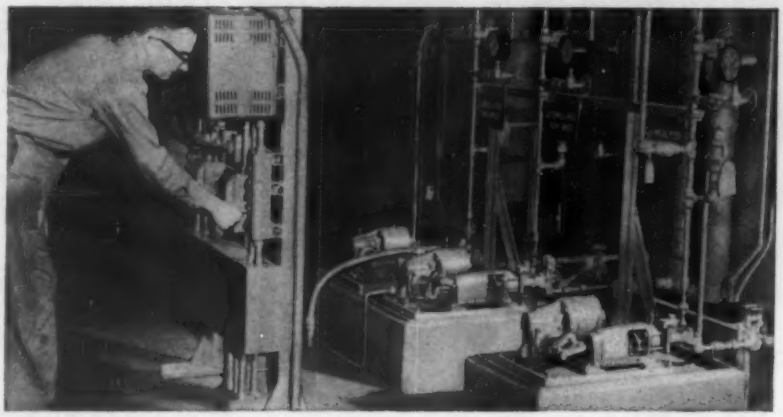
how to select the right metering pump for water treatment

SOFTENING, demineralizing, pH control, oxygen scavenging . . . all of the treatments commonly applied to water place special demands on chemical feed systems. Chemicals must be metered to a high degree of accuracy, but many of them, particularly the strong acids and alkalies, are themselves highly corrosive. Through the years, controlled volume pumps have proved the ideal metering technique in this field, combining accuracy, controllability, and corrosion resistance. But the question often arises, "Which controlled volume pump design is best for my water treatment needs?" Here are a few practical suggestions based on actual experience.



Standard Milton Roy MD pumps meter ammonium hydroxide to maintain desired boiler feedwater pH at Ohio Power Company. Milton Roy miniPumps also feed minute amounts of hydrazine to remove residual oxygen from feedwater at this generating station.

PUMP SELECTION GUIDE

FOR	USE THIS PUMP TYPE
Coagulation	
alum	MD
silicate	MD
Demineralization	
acid regeneration	Diaphragm / Mersemetric
alkali regeneration	Diaphragm
Softening	
conc. phosphoric acid	Diaphragm
conc. sulfuric acid	Diaphragm / Mersemetric
lime slurries	MD
phosphates	MD / H20
soda ash solution	MD
Oxygen Scavenging (Boiler Water)	
sodium sulfite	MD / H20
hydrazine	MD / miniPump
Calcium Precipitation (Boiler Water)	
phosphates	MD / H20
Carbon Dioxide (Boiler Water)	
neutralizing amines	MD / H20
filming amines	MD / H20
pH Control (Boiler Water, Process Water, Cooling Towers)	
caustic soda	Diaphragm / Mersemetric
sulfuric acid	Diaphragm / Mersemetric

Packed plunger pumps . . . MD, H20®, miniPump®

The standard Milton Roy MD pump is usually the first choice for metering water treatment chemicals. Highly accurate, its capacity is readily varied manually or automatically in response to treatment demands. A wide variety of materials of construction from cast iron to stainless steel withstand all mildly corrosive treatment chemicals. Capacities to 2056 gph, pressures to 1000 psi. *Bulletin 553-1.*

Non-corrosive chemicals can be metered economically with the H20 pump if constant speed operation is satisfactory. Though it cannot be adjusted in operation, this low cost pump is ideal for feed to packaged boilers. Capacities to 28 gph, pressures to 600 psi. *Bulletin 558-3.*

When extremely small volumes of chemical, from 20 to 2940 milliliters per hour, must be metered to accuracies of 1%, the Milton Roy miniPump is the right answer. That's why this design is just about standard for metering hydrazine in oxygen scavenging. Pressures to 1000 psi. *Bulletin 1257-2.*

Diaphragm liquid ends

The best pump for highly corrosive or otherwise dangerous treatment chemicals is the diaphragm pump, with a stainless steel or plastic diaphragm isolating the plunger from the treatment chemical. Positive air purging at each stroke eliminates any chance of air binding. And the diaphragm liquid end is readily interchangeable with the packed plunger liquid end of the standard MD pump, permitting economical modernization in the event of a change in metering requirements. Capacities to 400 gph, pressures to 2700 psi. *Bulletin 1157-2.*

Totally immersed liquid ends . . . Mersemetric®

Many special metering problems are easily solved by Mersemetric controlled volume pumps with the liquid end submerged to a depth of up to fourteen feet. Chemicals can be metered directly from storage tanks without any need for tank connections below liquid level. Mersemetric pumps are widely used to feed sulfuric acid to cooling tower water and deaerator effluent, and sulfuric acid or caustic soda for demineralizer regeneration. Capacities to 218 gph, pressures to 1200 psi. *Bulletin 1153C.*

If precision pumping of boiler water treatment chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

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Chemical Feed Systems • pH Instruments

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Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

DOUBLE-CIRCUIT, $200 million, 500-kv transmission line extending from the Bonneville Power Administration grid system as far south as Bakersfield, Cal., is now being studied as a beneficial prospect for the Pacific Coast states. Among the benefits claimed for such an interconnection are these:

Surplus Northwest peaking capacity could provide 1 million kw of firm power for California utilities to be used continuously over the peak hours, 8 A.M. to 10 P.M., five days a week. A peak load diversity of some 500,000 kw is expected to exist among Pacific Coast utility systems by 1964–65, and will increase.

Coördinated operation of the California and Pacific Northwest power systems would reduce the need for spinning reserves.

California would get the benefit of firm power and energy from Northwest hydro plants which may be installed considerably earlier than the development of loads they will ultimately serve. This would put off construction of high-cost thermal capacity in California, and at the same time increase wholesale power revenues in the Northwest.

ELECTRICAL GENERATING EQUIPMENT ordered by U. S. power systems from domestic sources for the first half of 1960 showed a capacity increase of 70 per cent over the same period of 1959, reports Edison Electric Institute. Orders for steam generators rose 97 per cent over a year ago, while hydraulic turbine orders were up by 212 per cent and power transformer orders increased by 96 per cent.

Total of 6,856,245 kw of new capacity was ordered by the end of June, compared with 4,043,250 kw ordered during the same period last year. This brought the total of scheduled additions to generating capacity for the period starting with 1960 up to 45,330,777 kw, of which 35,910,700 kw were in thermal units.

Amount of capacity represented by steam units in sizes below 100,000 kw was only 7.3 per cent. Eighty per cent of the capacity ordered was in units of 150,000 kw or more.

GROUND has been broken at Louisa, Ky., for Kentucky Power Co's $39-million, 265,000-kw Big Sandy Plant on the banks of the river of the same name. The station is expected to burn 750,000 to 800,000 tons of east Kentucky coal a year.

U. S. STEEL's Columbia-Geneva Steel Division has begun work on construction of an iron ore mining and beneficiation facility in Fremont County, Wyoming, some 26 miles south of Lander. After completion late in 1962, the project will supply pelletized iron ore to Columbia-Geneva Steel's integrated steel plant at Geneva Works, near Provo. Known as the "Atlantic City Project," the location is 8300 ft above sea level.

NEW TYPE of sewage plant has been installed in the suburban community of Beaconsfield, Quebec, Canada. Based on a method called Atomized Suspension Technique, such a plant destroys odors and bacteria in sludge, burning it to inorganic ash in a very short time. Such a plant can be built on 50 sq ft of ground. Cost of an AST unit is reported to be about $35,000.

Steps in the AST system are: 1. raw sewage is settled in a standard preliminary settling tank. 2. Sludge is concentrated to 10 per cent solids in a smaller tank. 3. Sludge is ground to chop up fibrous materials, and then pumped to the top of a 20-ft high, 2-ft-diam tank.

Walls of the tank are heated to 1000–1400 F. Sludge is atomized into it at about 150 psig. Moisture flashes into superheated steam, which carries suspended particles of solids down the tower. Solids are dried by the time they are half-way down the tank. Air at low pressure is introduced into the tank. Solids combine with the oxygen, and the organic matter burns. Jet condenser is used to condense the steam carrying this ash. Finally, condensate and ash pass through a scrubber and are discharged to the river.

AVERAGE RATE paid by home users of TVA electric power edged down to an all-time low in the fiscal year which ended June 30. This average was just under one cent a kwh for customers in the TVA service area. Residential users of electricity across the nation pay an average of about 2½ cents a kwh.

Average annual use of electricity in homes served with TVA power also set a new record during the fiscal year — 8806 kwh. That is

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15 times as much as was used in the average home in the area when TVA was established in 1933.

Over the past year, TVA power production reached an all-time high of 63.4 billion kwh. The steam plants consumed 18.6 million tons of coal, or an average of 0.805 lb for each kwh generated.

A 600,000-KVA power transformer, with 50 per cent more capacity than any transformer now in use, will be built by Westinghouse for a Midwest utility. The new unit will raise the generated voltage from 20,000 to 138,000 v so that power may be transmitted economically to the load center.

CONSULTING engineers now have a manual of recommended principles in The Practice of Consulting Engineering, which is being distributed to member firms by the Consulting Engineers Council of Springfield, Ill.

UHL, HALL & RICH, a partnership affiliate of Chas. T. Main, Inc, of Boston, recently received the Award of Honor of the National Safety Council. As engineers to the Power Authority of the State of New York, Uhl, Hall & Rich established a record of 1,269,912 injury-free man-hours during the construction of the St. Lawrence Power Project, covering the period from April 22, 1957 to December 31, 1959.

FIRST SUIT to be instituted under the enforcement provisions of the Federal Water Pollution Control Act involves the City of St. Joseph, Mo. Secretary of Health, Education, and Welfare, Arthur S. Flemming, has asked the Department of Justice to bring suit on behalf of the United States to secure abatement of pollution of the Missouri River by that city.

OUTSTANDING CONTRACTS: ASEA (Allmanna Svenska Elektriska Aktiebolaget) from Sweden has been awarded a contract to supply the ten main transformers for the Oahe Reservoir Project, located on the Missouri River near Pierre, S. D. The contract, valued at $1,189,000, is for one 103,000-kva 3-phase transformer and nine 68,667-kva single phase transformers plus spare parts. ASEA will be responsible for designing, manufacturing and testing this equipment. This is said to be the first large award by a U. S. government agency to a Swedish electrical manufacturer.

A $22 million contract covering electrical drives, motors and controls for one of Latin America's largest industrial projects, an integrated steel mill in Brazil, has been awarded to Westinghouse. Companhia Siderurgica Paulista is building the mill, which will have an initial annual capacity in 1962 of 600,000 tons of sheets and plates. The mill is in Piacaguera, in the state of Sao Paulo, and is scheduled for full production in 1967 when its capacity will be 2.5 million tons of finished products.

UNION ELECTRIC CO is acquiring land along the Alton Pool of the Mississippi River in St. Charles County, Mo., as a future site for a large steam power station. The plant will eventually have at least 1,500,000 kw of capacity. Date for starting construction is not yet fixed, but construction of the first section is expected to start within the next few years. Final section will not be completed until the 1970's.

GE's Atomic Power Equipment Dept has designed and installed a special incinerator which is expected to reduce the cost of disposing of contaminated wastes from the plant's fuel manufacturing operation by 75 per cent.

SUCCESSFUL testing of a new automatic coal sampling device has been done at the Chesapeake and Ohio and Baltimore and Ohio railway piers in Toledo, Ohio. A special committee of coal producers, shippers and consumers has been working on the project. A second committee composed of railroads which operate coal dumpers at lower lake ports in Ohio is studying capital and operating costs of installing the new sampler.

The device will automatically secure samples from rail cars as the coal is loaded aboard ship. It consists of three steel tubes mounted on the cradle of the dumping machine. Samples of coal are collected in openings in these tubes and removed for laboratory analysis. Tests show a high degree of agreement between samples from the same cars taken at the mine tipples and the sampling device.

Design of the sampler was the work of Armand Bur, mechanical engineer with the Cleveland Electric Illuminating Co. Engineering and construction work in the testing has been done by Fairfield Engineering Co.

MARK YOUR CALENDAR: 24th National Exposition of Power and Mechanical Engineering, to be held Nov 28 to Dec 2 at the New York Coliseum, in conjunction with ASME's winter annual meeting.

Fall meeting of NSPE will be held Oct 19–21 at the Statler-Hilton Hotel in Denver.

16th annual National Conference on Industrial Hydraulics is scheduled for Oct 20–21 at the Sherman Hotel in Chicago.

Cleaner Air Week, sponsored by Air Pollution Control Assn, will be observed Oct 23–29.

Fall meeting of the National Fluid Power Assn is set for Oct 31–Nov 2 at the Edgewater Beach Hotel in Chicago.

October is National Science Youth Month. National organizations will coöperate with Science Service in programs everywhere, to inspire and inform youth in our schools about career opportunities in science and technology.

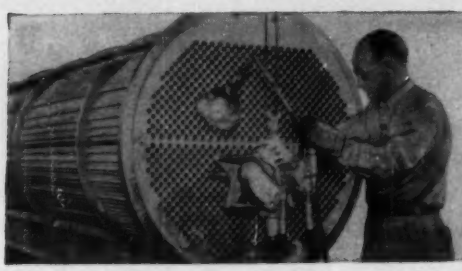
Louisiana Polytechnic Institute's School of Engineering, Ruston, La., has scheduled its 9th Annual Instrumentation Conference for Nov 3–4.

AIEE's second Power Industry Computer Application Conference will be held Nov 9–11 at the Chase Hotel in St. Louis. Latest developments will be presented in digital computers for utility engineering and plant automation.

National Conference on Water Pollution will be held under the wing of the U. S. Public Health Service, Dec 12–14 at the Sheraton Park Hotel, Washington, D. C.

National Electrical Week will be celebrated Feb 5–11, 1961. Address of the organizing committee is Suite 306, 407 N. 8th St, St. Louis 1, Mo. Program or announcement copy is available without charge.

Next National Nuclear Congress is set for New York, in 1962.



CONDENSER AND HEAT EXCHANGER CLINIC

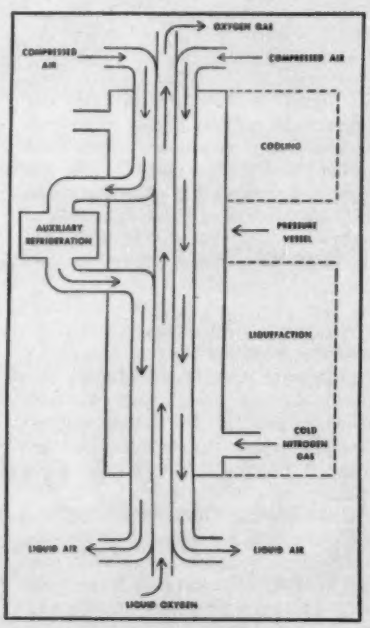
Edited by Arthur W. Tracy, Metallurgical Engineer
Anaconda American Brass Co., Waterbury, Conn.

Cryogenic heat exchanger uses 16 miles of copper tube

A copper-tube heat exchanger used in the production of oxygen and nitrogen in a large low-temperature processing plant made by AIR PRODUCTS, INC., Allentown, Pa. The ⅜" tubes are wound tightly and built up layer by layer for greatest possible surface contact – and maximum heat transfer between the oxygen and air tube systems (see diagram below). AIR PRODUCTS winds bundles from long lengths of Anaconda tube. A total of 85,200 feet is used in this exchanger, for a total weight of 14,500 pounds. The "button-hook" manifolds for the tube systems are of Red Brass pipe, with extra-heavy or double-extra-heavy wall.

In applied cryogenics – the use of low-temperature techniques for gas liquefaction and separation and for the handling and application of these gases – the unique properties of copper and copper alloys become particularly important. The high thermal conductivity of copper – the highest of any commercial metal – is essential for economical heat transfer in large volumes of fluids. Outstanding corrosion resistance is important. And finally, copper has no tendency to brittleness at very low temperatures, and the strength of copper and copper alloys is significantly higher at –300F than at room temperature.

The use of low-temperature processing and of liquefied gases is rapidly increasing in the chemical industry, in basic metals industries, and in space and missile fields. And new applications are being found constantly. Anaconda American Brass Company specialists are available to help select the alloy best suited to your job. For more information on tubes for heat transfer, or for technical assistance, write: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. BOGST.



Schematic diagram of heat exchanger used in the production of oxygen and nitrogen. Incoming air under pressure passes through a set of coils in the exchanger and is cooled by counter current heat exchange by cold outgoing oxygen and nitrogen. Oxygen from the distillation column enters the heat exchanger as a liquid under pressure and, in removing heat from the air, vaporizes to a gaseous form and leaves the heat exchanger at near entering air temperature. Part way through the heat exchanger, the air is removed from the heat exchanger and sent through a Freon cooling system for auxiliary refrigeration and then returned to the exchanger for final cooling.

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Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ When in Spain this summer, POWER ENGINEERING's editor, **Bob McCaw**, visited a refinery and there noted oil burners in use made by National Airoil Burner Co of Philadelphia. McCaw took a snapshot of this happy evidence and sent it to the manufacturer. Replies **William Ferguson**, vice-president of the company's Chemical-Petroleum Div:

> Thank you for your photograph of our burners installed in an Alcorn Crude Furnace at the Caltex Refinery in Cartagena, Spain. A few months ago we supplied larger capacity parts to increase the designed crude rate on this heater. We had often wondered if this program had ever been completed. Your photograph proves without doubt that the change was consummated.

▶ American way to control growth of mussels that interfere with a power plant water system, described in this department in July, will be tried out in Ireland. Writes **W. Cronin** of the Electricity Supply Board in Dublin:

> I wish to thank you for your letter enclosing copy of a letter from Stearns-Roger Mfg. Co. The information contained in their letter will be of great assistance to us and we shall try it out and let you know the results we obtain from the treatment suggested.

▶ The movement, launched in 1957, to preserve the historical equipment and literature of the electrical industry seems to be having a difficult time in getting off the ground. **E. S. Lincoln**, of New Fane, Vermont, acting director of the Electrical Historical Foundation, writes:

> I am sorry to say that I doubt if such a proposed museum will ever be built, due to the lack of interest in the electrical industry, especially the utilities. The equipment is available and we have thousands of historic items on hand, but are unable to obtain funds for its storage and preservation. Unless we can obtain a few thousand dollars in the near future the equipment will have to be sold for junk.

It seems a pity that such a worthy cause should not be more widely understood and supported. Those who are drawn to it but who do not have details, would benefit by writing Lincoln for a copy of the document, A Proposed All-Electric Museum Covering a Chronological History of Electricity.

▶ **Arthur E. Hill**, of the American Power Dispatchers Assn, reports that the group held its annual meeting recently in Riverside, Cal, with dispatchers from the Canal Zone, City of Seattle, Arizona Public Service, Pacific Gas and Electric, and from the Southern California area in attendance. President of the Association is **Fred Niemeyer** of California Electric Power Co.

▶ **FPC** has revised its forecast of total generating capacity which will be reached in this country by 1980. The figure is now 467 million kw, which is 16 million higher than was predicted in a report issued in June of this year. At the end of 1959, the total U. S. generating capacity stood at 174 million kw. Peak demands of electric utility systems in 1980 are now expected to reach 380 million kw.

▶ New basic explanation for the corrosion of iron has been advanced by scientists at the Westinghouse Research Laboratories. **Earl A. Gulbransen** and **T. P. Copan** suggest that the true culprits are hydrogen ions, or protons — one of the basic building blocks of matter.

Until now, a standard explanation for iron corrosion is that it is an electrochemical reaction, somewhat similar to that which occurs in an ordinary battery. The new theory suggests that something more fundamental takes place in the iron, even though an electrochemical reaction also may be present.

In a series of experiments that eliminated the conditions required for electrochemical reactions, the Westinghouse scientists reduced the complex rusting or iron to its simplest atomic processes.

> We conclude that the hydrogen ions in the water vapor enlarge the areas of chemical reaction between the oxygen and iron and bring about the metal's greatly increased corrosion. At the lower temperatures at which iron usually rusts, this basic reaction is masked. Complex corrosion products are formed and are not stable, and the corroding metal is often removed from the reaction site.
>
> Once such basic understanding is at hand, we should be able to do a much better job of controlling corrosion. Already we can identify two control measures which must be considered in addition to any electrochemical effects that are involved in iron rusting: hydrogen must be prevented from entering the metal, and the growth of the localized reaction sites must be inhibited by the addition of suitable alloying elements to the iron.

▶ **Ernest C. Gaston**, president, executive division of Southern Services, Inc, of Birmingham, Ala., has received the George Westinghouse Gold Medal from ASME for achievement in the power field.

William T. Williams, manager of operations for Detroit Edison Co, has retired after 39 years of service.

Raymond E. Hess, associate executive secretary of American Society for Testing Materials, has been named acting executive secretary. **Robert J. Painter**, executive secretary since 1952, is to be consultant to the executive secretary.

Thomas I. Crowell, Jr, retired vice-president of the New York consulting engineering firm of Ford, Bacon & Davis died July 21. He was 66.

the impossibility of operating our modern community without proper liquid moving equipment. Pumps of all types and sizes are operating 24 hours a day, moving the "life blood" of our social and business society.

Considering the necessity of reliable liquid handling in industry, we think you would find it advantageous to use "Buffalo" pumps for your important liquid handling jobs.

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new Yarway Unit Tandem Valve for blow-off service up to 665 lbs. WSP ...provides proven Yarway Unit Tandem dependability for medium pressure installations. Streamlined, light in weight, easy to operate, tight sealing, with minimum maintenance.

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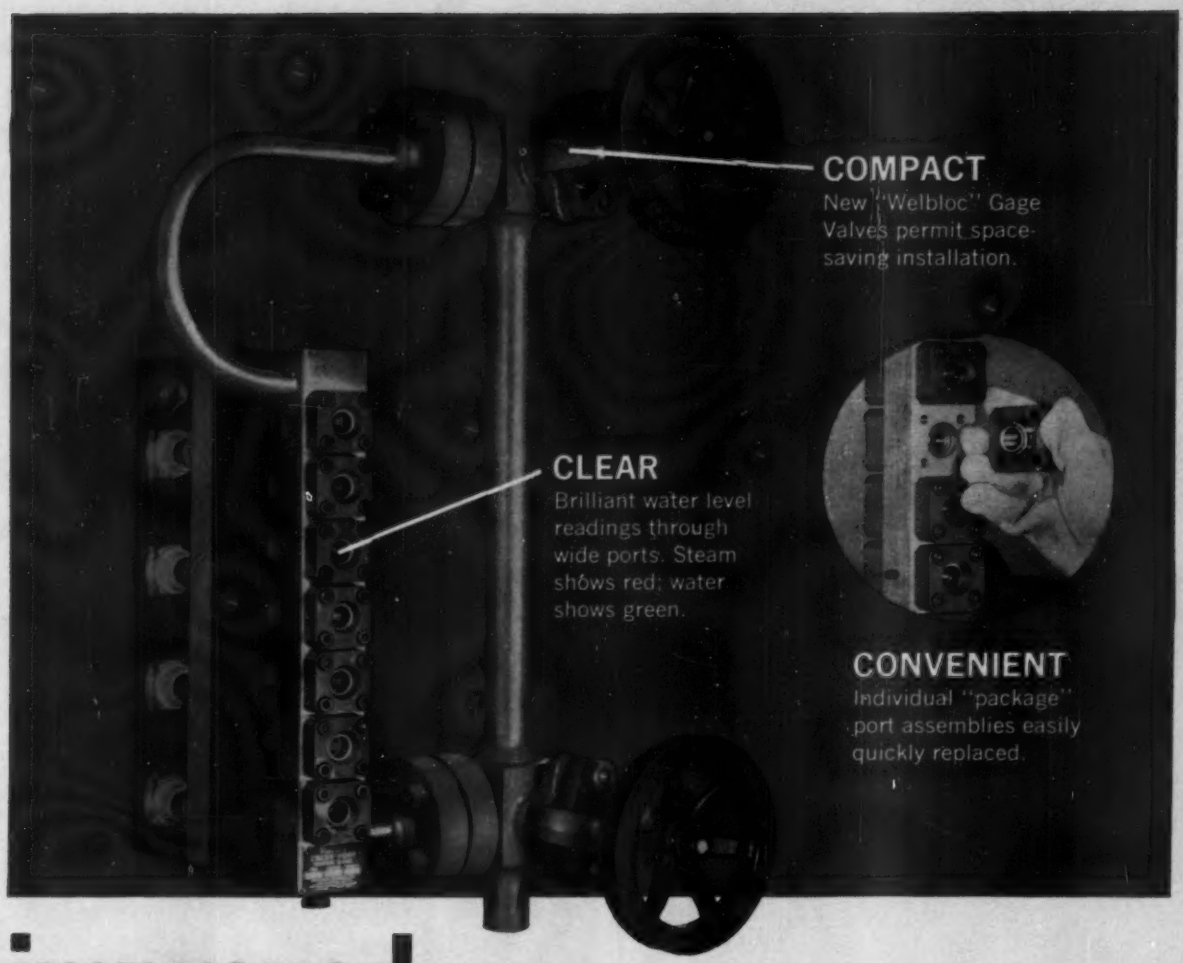
TRIM
Both valves, mounted together, permit more compact piping with reduced weight.


COMPACT
New "Welbloc" Gage Valves permit space-saving installation.
CLEAR
Brilliant water level readings through wide ports. Steam shows red; water shows green.
CONVENIENT
Individual "package" port assemblies easily quickly replaced.

improved Yarway Color-Port Gages for medium pressure boiler service to 1050 psi*—with new "Welbloc" Gage Valves—offer you reduced maintenance, increased operational time, brilliant red and green level readings.

*High pressure design for pressures to 3000 psi also available

Write for new Yarway Bulletin WG-1815

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.

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Allis Chalmers Company	General Chemical Co.	E. I. du Pont de Nemours & Co.
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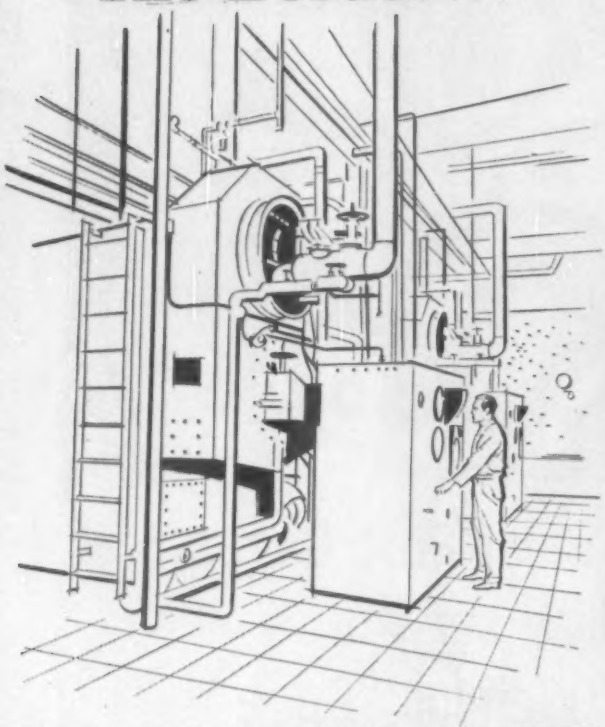
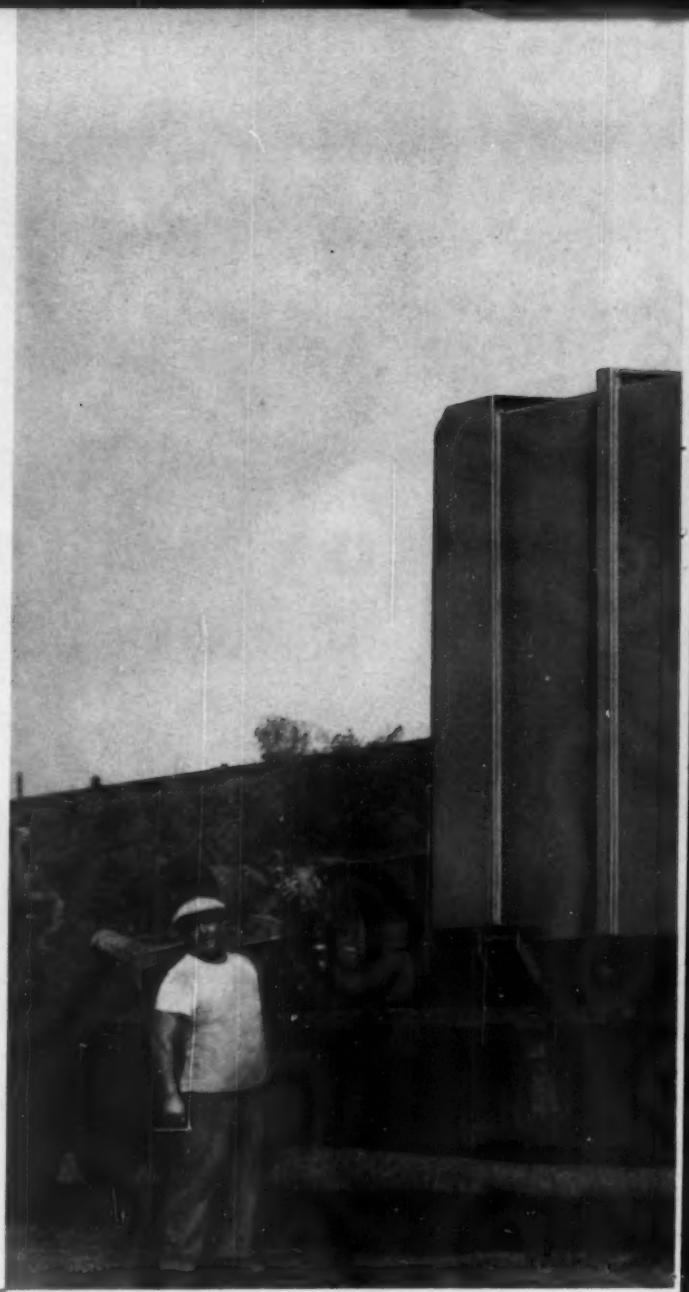
First B&W Shop-Assembled Boiler Ever Built Starts Life #2 South of The Border...

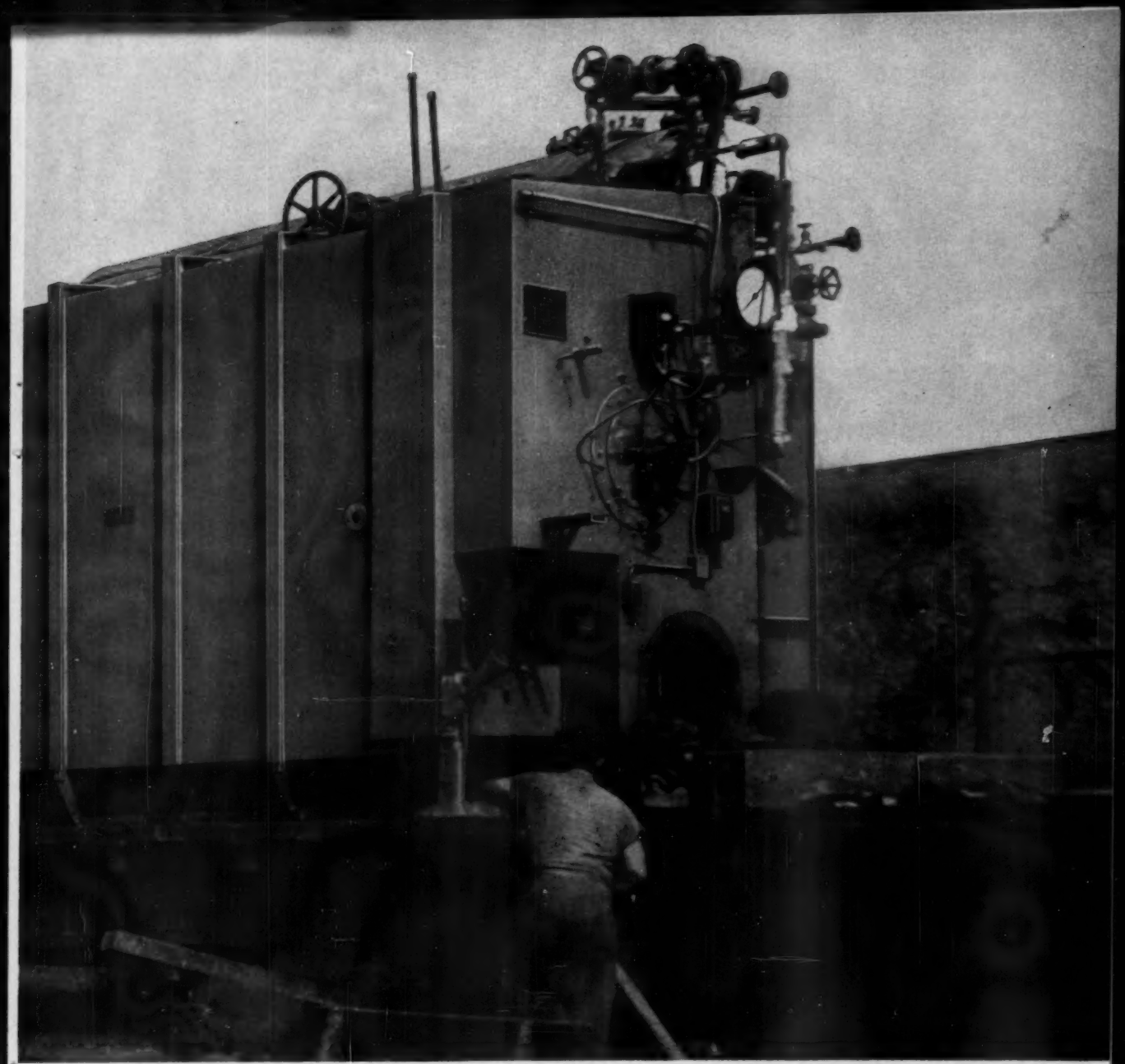




Number 1 of Nearly 1,000 Similar Units Meets Expanding Steam Requirements of Mexican Textile Firm

A decade ago, a major cleaning and laundering concern in Staten Island, N. Y., needed a dependable supply of steam for their massive laundering operation. In filling that need, B&W designed and delivered its first shop-assembled boiler. Operating at 165 psi and 358 F, this oil-fired package boiler served the company to perfection with 20,000 lb of clean, dry steam per hour.

The Staten Island firm had continuing success with this new departure in boiler design and in less than two years, the unit had paid for itself. The recent advent of the automatic washer and dryer, however, has so changed the laundry business that the firm now finds itself predominantly a dry-



cleaning establishment. Having no further need for a unit as large as the FM-type boiler, the original owner recently sold it (at a good percentage of its original cost) to another B&W customer, the Textiles y Acabades Company of Mexico. Today, the boiler continues its fine record, generating heat and process steam for the Mexican textile firm.

Indicative of the *built-in* durability of B&W units, the "times and travels of FM-1" are further evidence in action of dependable steam generation by B&W. Whatever *your* steam requirement . . . whatever your most economical fuel, B&W has the boiler best suited to your application. Your local B&W representative has all the facts on your area. Call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

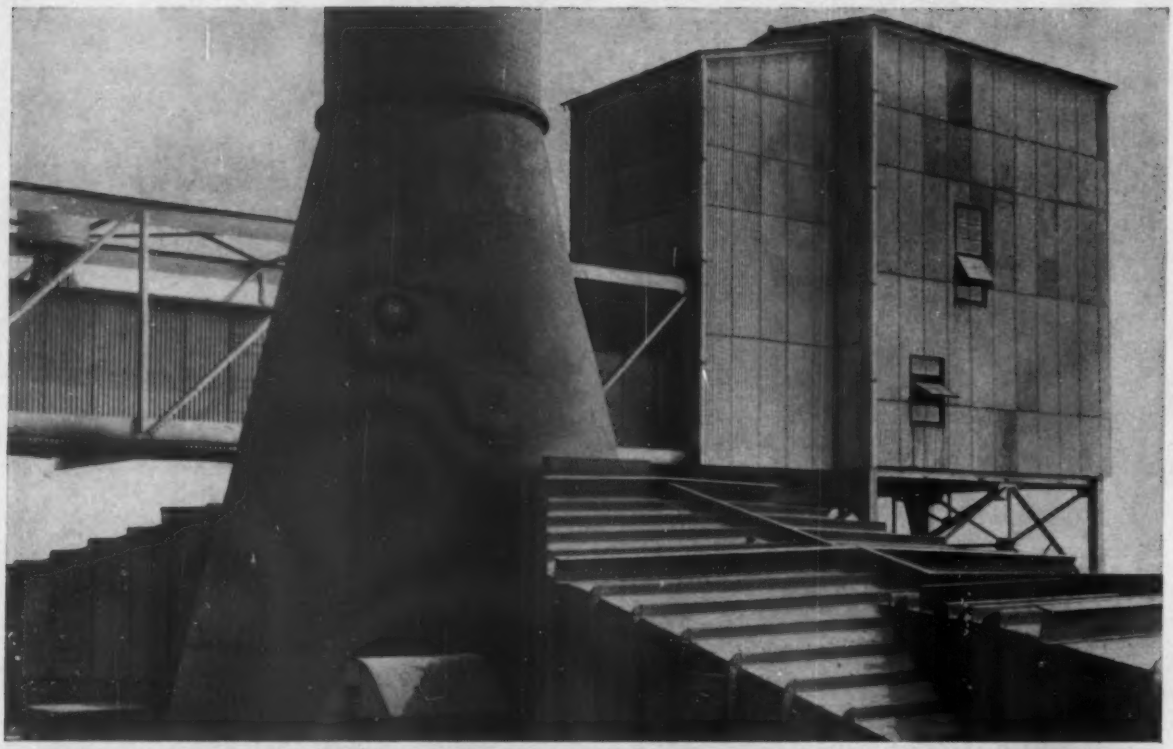
B&W — THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-980-16

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION



Guniting of stacks and breechings at Ohio Edison Company, Shadyside, Ohio. **Contractor:** Gunite Concrete & Construction Co., Kansas City.

Protect steel stacks with corrosion-resistant concrete

Another stack and breeching is being protected with corrosion-resistant concrete linings made with LUMNITE calcium-aluminate cement and suitable aggregates. This lining will resist the corrosive action of flu-gas condensate that forms on stack interiors.

Insulation is added, too. Monolithic concrete linings keep stack gases hot, help maintain better draft for greater operating efficiency.

In addition, there is less tendency for gases to reach dew-point. And the steel shell stays cool, prolonging the life of exterior paints.

Gunited or plastered, installation is fast, easy, economical. The concrete reaches service strength within 24 hours. For greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready to use with just the addition of water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

L-205

"USS," "Atlas" and "Lumnite" are registered trademarks

Universal Atlas Cement
Division of
United States Steel

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

For more data circle 508 on Post Card

WHERE DO YOU STAND ON COMPUTER CONTROL— LEADING OR LAGGING?

Far-sighted leaders in industry are realizing the benefits made possible by applying computer control systems to their processes.

Working with these leaders, General Electric has already pioneered the application of twenty on-line GE-312 computer systems now being implemented in these basic areas —STEEL, ELECTRIC UTILITIES, CHEMICAL, CEMENT, and PRODUCTION CONTROL for various manufacturing applications.

The GE-312 Computer Control System embodies adaptability and flexibility to meet many types of applications in varying size plants. For example, compare its expansible memory—capacity up to 52,000 words. Compare its flexible input/output—capable of scanning up to 1500 instrument inputs. These are maximum capabilities, expansible from a minimum system. You buy a system tailored to your exact requirements.

Add to this versatile equipment the computer systems engineering ability demonstrated by General Electric in implementing these twenty GE-312 system applications.

Add also the long history of General Electric overall systems know-how—its broad background in the equipment, processes and materials to which you apply computer control.

Tomorrow's profits will come from today's combination of vision, equipment, and know-how. *Where do you stand?*

There are General Electric Sales and Application engineers in over one hundred offices throughout the nation to serve you. *Phone* the nearest General Electric Apparatus Sales Office, or *wire* General Electric Computer Department, 13445 North Black Canyon Highway, Phoenix, Arizona.

PROCESS CONTROL
AUTOMATED BY GENERAL ELECTRIC

Progress Is Our Most Important Product

GENERAL ELECTRIC

CPA-50 (9-60)

General Electric—a pioneer in computer systems for all phases of business, industrial, scientific, engineering, and financial endeavor.

For more data circle 509 on Post Card

The Story of Edward Research

and the "Perfect" Globe Valve

Edward designers built the Figure 848 forged steel globe valve from scratch. In an art where most development effort must be directed toward modification, adaptation, and refinement of existing technology, the 848 story is almost unique. The objective was simple: To design and construct a perfect 600-lb-class globe valve in the ¼" to 1" size range. (Basic rating 600 lb at 910 F, 2000 lb WOG.) That the project was virtually successful is a tribute to the ingenuity of the Edward Research Staff and the equipment which enabled them to validate their progress. Here, is that story.

Three areas were given special consideration by the Edward staff of engineers and metallurgists when they set out to design a "perfect" valve. They were: 1. Body Shell and Bonnet Joint; 2. Seat Tightness; 3. Packing Area. Although each area was treated separately, the relationship of one to the other was a factor that had a great deal to do with the outcome of the project.

A series of "torture" tests such as the pressure pulsator shown on the opposite page carried each part and joint to the point of destruction. Thus Edward designers were able to trace each weakness to its source. Perhaps no other valve ever designed has been known and understood so well by the men who designed it.

1. BODY SHELL AND BONNET JOINT. The valve bonnet was bolted finger tight; it tested at 2000 psi. Then, at full design tightness on all four bolts, the bonnet joint did not leak until 11,000 psi (5½ times design pressure!) was applied. Next, 8000 psi applied 100 consecutive times produced no apparent valve damage. Internal pressure was pulsated from 200 to 2000 psi for 10,000,000 cycles with no apparent damage!

The bonnet cap screws were subjected to 350% of design tightness before failure occurred. Further evidence of design effectiveness was the unpredictability of failure. In one case the threads stripped; in another the bolts broke off, and in other there was excessive bending of the bonnet flange. There was no *one* apparent point of weakness!

2. SEAT TIGHTNESS. Similar destructive tests were conducted on the valve stem and seat. The valve required on 65% of standard test closing torque to seal tight at 2000 psi. And 350% of standard torque was built up before the stem sheared below the handwheel. 100 operations at 2½ times standard torque did only negligible damage to seating surfaces. Even after this test only 90% of standard test torque was needed to hold 2000 psi.

3. PACKING AREA. Six times as much load as actually required to seal the packing chamber was applied to the gland bolts without causing damage. A load 3¼ times greater than required for sealing was applied 50 times, also without causing damage.

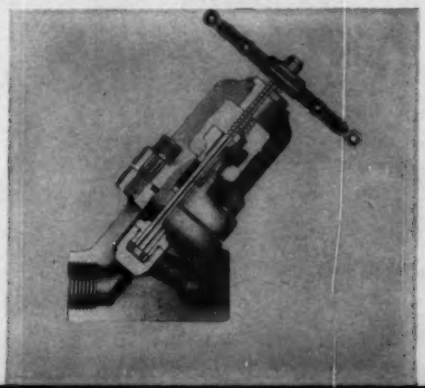
Thus the "perfect" globe valve was designed; perfect not because it can't fail, but perfect because it has no apparent weaknesses. The full design and construction story is told in Edward Catalog 14-G.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

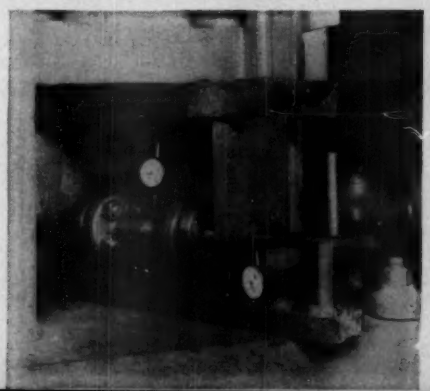
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Chief Engineer C.A. Siver and Design Engineer Don Easton observe effects of pulsating pressure on newly designed Figure 848 forged steel globe valve in Rockwell-Edward Research Lab.

Rugged forged steel body . . . combined with high-strength stainless steel gland bolts and bonnet bolts, aluminum-bronze alloy yoke bushing, asbestos-stainless spiral gasket and other premium features . . . makes the Figure 848 a virtually "perfect" small steel valve.



Test arrangement produces uniform bending moment on valve and ½" pipe. Test shows that the strongest pipe likely to be attached to the valve will yield with less than ½ the bending moment required to distort body.



Kentucky Power Company puts America's first Marley-Mouchel HYPERBOLIC NATURAL DRAFT at Big Sandy Plant

At Kentucky Power Company's Big Sandy Plant, a Marley-Mouchel Natural Draft cooling tower 320 feet high and 245 feet in base diameter will be an innovation in American generating station design. This is the latest major power plant to be built on the American Electric Power System.

Engineers of American Electric Power Service Corporation, who are designing this 265,000 kilowatt plant, made a comprehensive study of hyperbolic cooling towers vs. mechanical draft cooling equipment to furnish 120,000 gpm of condensing water for this steam generating unit. The conclusions were that this "different" type of tower offers many exclusive advantages, all of which complement and contribute to their major objectives. Consider these:

SERVICE LIFE: Any foreseeable term of years. (Counterparts of this tower are operating efficiently after 35 years of service.)

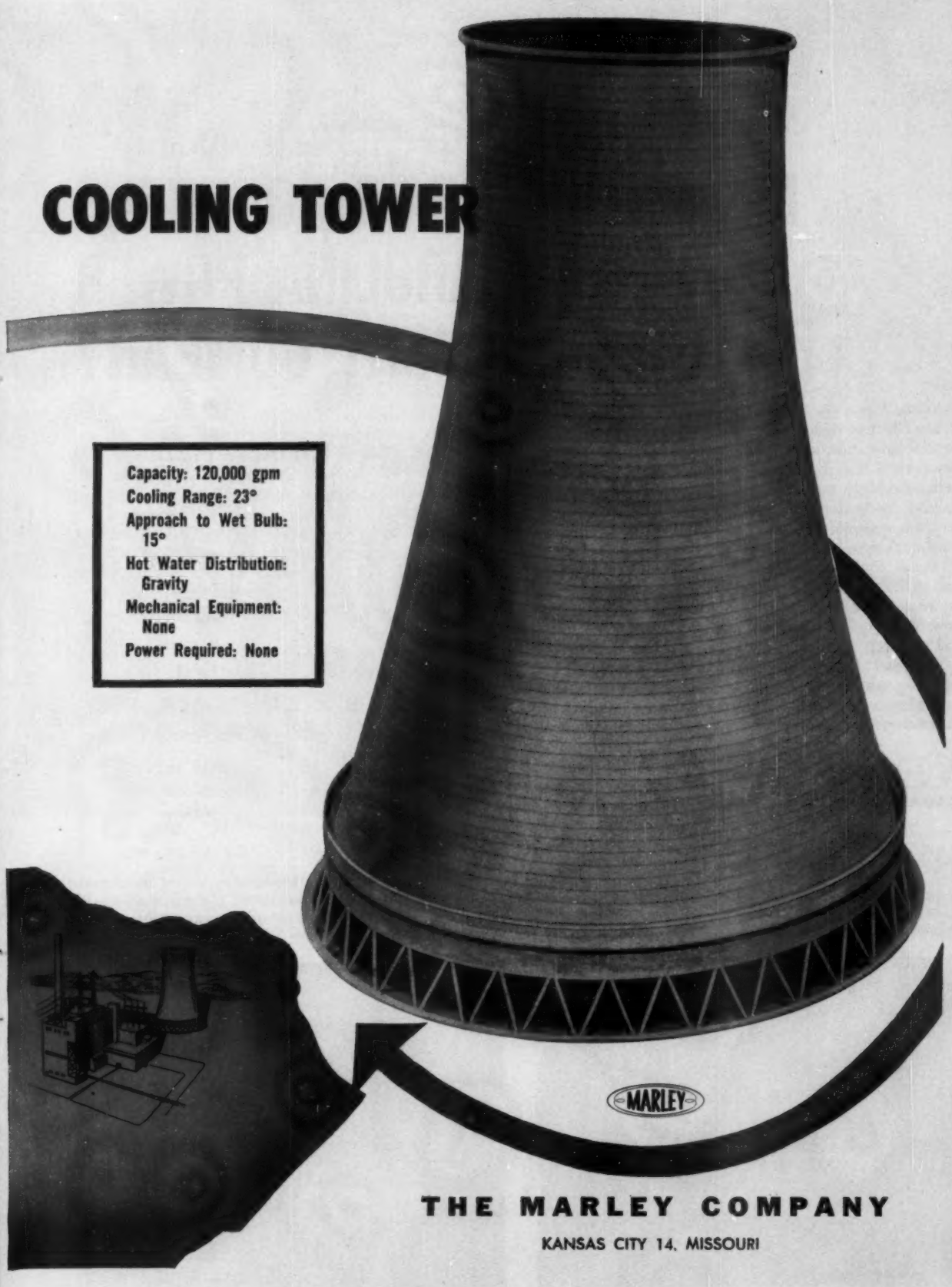
PLANT SITE UTILIZATION: Requires less area than ordinarily occupied by towers of like capacity. Can be located adjacent to other structures with resulting piping economy.

POWER REQUIREMENTS: None, other than pumping, thus making plant product, ordinarily required for auxiliary power, available for saleable distribution.

MAN HOURS FOR MAINTENANCE: No service operations contemplated for many years.

COLD WEATHER OPERATION: Full tower capacity available without ground fogging; a plus value due to high level discharge.

COOLING TOWER



Capacity: 120,000 gpm
Cooling Range: 23°
Approach to Wet Bulb: 15°
Hot Water Distribution: Gravity
Mechanical Equipment: None
Power Required: None

MARLEY

THE MARLEY COMPANY

KANSAS CITY 14, MISSOURI

For more data circle 511 on Post Card

MINIMUM SPACE . . . MAXIMUM RELIABILITY . . .

MAGNETIC BOILER CONTROLS FOR CAROLINA POWER & LIGHT COMPANY

Carolina Power & Light Company's H. B. Robinson Steam Electric Generating Plant, which went into commercial operation early in 1960, at Hartsville, S.C., is the world's first public utility steam generator unit to have solid state, magnetic, boiler control systems. Combustion, feedwater, pump recirculation and steam temperature controls are all Hagan PowrMag (magnetic amplifier) systems.

Hagan controls were chosen for this 182 megawatt station for several reasons, all of them stemming from the basic considerations which guided the design of the PowrMag system—flexibility, dependability, accuracy and simplicity.

The PowrMag system utilizes dependable operational magnetic amplifiers as the basic control elements. The PowrMag controller has a plugboard into which may be inserted resistors and capacitors to provide *any* control action. This modular construction eliminates inventory problems, and provides maximum flexibility in the system. Easy to install and maintain, PowrMag systems use 1 to 9 v DC transmission and are designed to complement digital computer control.

Are you looking for controls that are dependable, do not require an electronics engineer to understand, and offer the ultimate in flexibility of application? A letter or phone call will bring you Bulletin MSP-163, which has the details on PowrMag. Or ask for a Hagan engineer to work with your own design department.

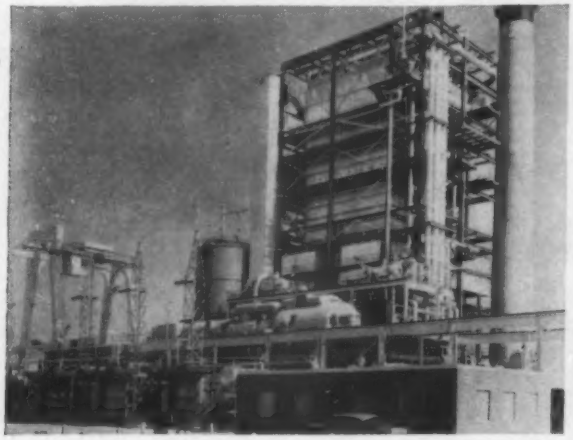
HAGAN

CHEMICALS & CONTROLS, INC.

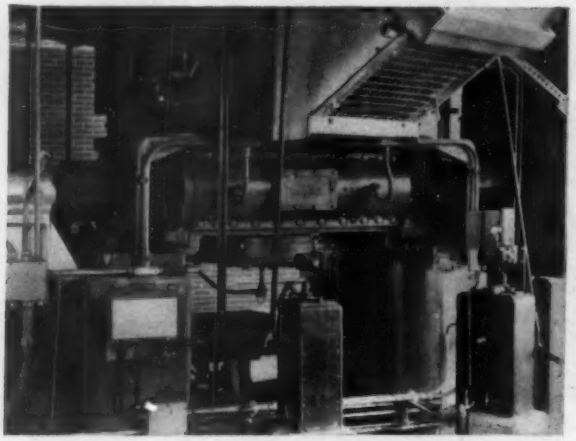
HAGAN CENTER, PITTSBURGH 30, PENNSYLVANIA

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

An outdoor, 1,260,000 lbs/hr steam generator with divided furnace, the Robinson Plant is pulverized coal fired. Steam is supplied at 1800 psig, and 1,000F/1,000F.



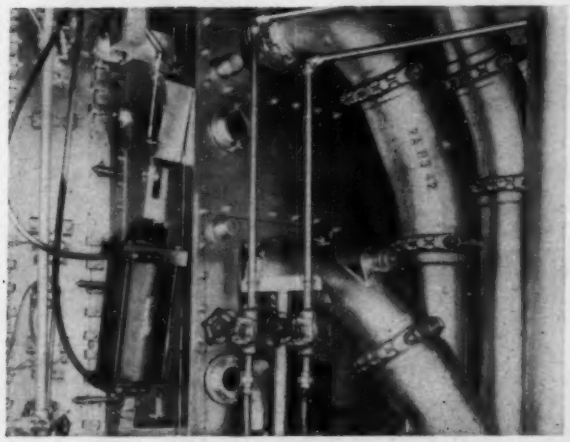
(Left) PowrMag pressure transducer, a simple transformer device without amplifier, converts mill suctions to a 1-9 v DC output. (Center) Pulverized coal mill feed positioner. (Right) Mill hot air damper positioner.



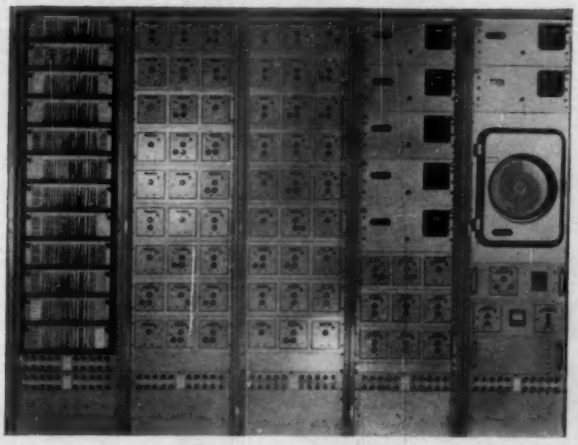
ANOTHER HAGAN FIRST...

One man controls the operation of the entire plant, including the boiler, turbine, pumps and related equipment, from this 36"-wide console. PowrMag remote control stations on the panel are miniaturized—only 2¼" x 5¼". Ebasco Services, Inc. were the consulting engineers and were responsible for the design of this compact BTG board.

Burner tilt positioner. An important part of the steam temperature control system on the Combustion Engineering Co. divided furnace unit.



Controller panel. Patchboards at left of panel permit interconnection of system. Other racks contain PowrMag controllers and PowrAmp amplifiers for various system functions; together with programmers for steam pressure and steam temperature during startup and shutdown.



For more data circle 512 on Post Card

How high speed gas turbines make possible new Solar centrifugal compressor for industrial use

by Leon Wosika, chief of preliminary design
and John Glessner, project engineer
Solar Aircraft Company

The development of the high-speed industrial gas turbine is resulting in improvements in industrial equipment used in conjunction with these prime movers.

A practical centrifugal compressor for the low-volume range is one of the first of these developments.

Traditionally, reciprocating compressors have been used in the range from 500 to 1000 hp when suction pressures are from 200 to 800 psi and volume flows are 100 to 1000 cubic feet per minute at suction temperature and pressure.

It has long been known that a centrifugal compressor would be less expensive to own and operate in this range if high speed drivers were available. For example, direct drive speeds from steam turbines have been limited to 10,000 to 12,000 rpm. When gears are used to obtain high speeds, their cost and complexity has made the compressor-set look less attractive. So, in the range from 100 to 1000 suction cubic feet per minute, a low speed, conventionally designed centrifugal would have to employ compressor rotors of perhaps 15 inches in diameter, and would necessarily have very long, narrow flow passages – resulting in poor efficiency.

Now, however, the availability of industrial high speed drivers, particularly the Solar Saturn T-1000 gas turbine engine, has provided the impetus for Solar to design and build a line of efficient centrifugal compressors for the low volume range. The compressor uses compressor rotors seven inches in diameter. At approximately 20,000 rpm, wheel tip speed is only slightly over 600 feet per second, resulting in low pressure ratios per stage. High rpm and low tip speed plus careful design result in a high efficiency of 70 to 75 per cent.

High efficiency is not the only immediate advantage of Solar's compressor. When it is coupled with a gas turbine in the 500-1000 hp range, no gearbox is necessary since the turbine rotating speeds of about 20,000 rpm match those of the compressor.

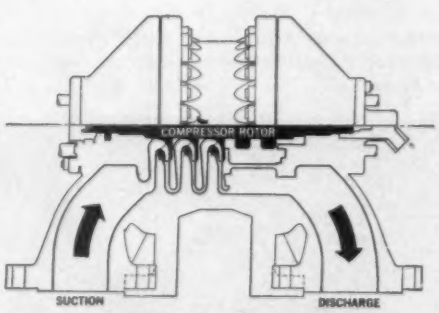
Together, the two machines make a lightweight, compact package – in the case of the Saturn T-1000 turbine, less than 7000 lbs and 300 cubic feet. This factor makes transportation and installation much easier and more economical than with the traditional compressor installation.

This portability makes central maintenance in a convenient, well-equipped shop a practical reality. In addition, the small size, light weight and absence of unbalance forces minimize foundation requirements.

A truly unique feature of the compressor is its modular design – the use of interchangeable staging to accommodate changing pressure and flow characteristics. High efficiency is maintained over the entire range of flows, 100 to 1000 suction cubic feet per minute, by use of pre-engineered, off-the-shelf compressor stages. Each stage is designed for a different flow, but is mechanically interchangeable with any other stage.

Several advantages result from modular design: (1) It reduces costs, mainly through volume production of parts and improved manufacturing methods. (2) It gives the compressor extreme service flexibility by allowing the quick change of stages in the field to accommodate new flows and pressures. (3) It allows quick delivery because all parts may be shipped directly from stock with no factory modifications necessary. (4) It tends to increase reliability and efficiency through repetitive manufacture of standardized parts.

If you wish additional data on either the compressor or the Saturn T-1000 turbine, or both, write Dept. H-163, Solar Aircraft Company, San Diego 12, Calif.



Solar Centrifugal Compressor

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company

For more data circle 513 on Post Card

parallel construction

DEKORON®

NEW METL-COR

now with number coding

Dekoron New Metl-Cor is an exciting instrument harness design that simplifies and speeds installation of tubing... makes neater and tidier tubing installations — because New Metl-Cor, with exclusive parallel-tube construction, is now number-coded every 2 inches.

That means there's no delay caused by trial-and-error compressed-air testing of lines. Follow the number code and hook-up correctly the first time. There's no untwisting of corkscrew tubes. Peel the sheath back and connect straight lines fast. Dekoron New Metl-Cor also features an improved polyethylene sheath for maximum corrosion and impact protection and proven Dekoron quality — all at no increase in price.

Tube up with the best... it costs you less. Tube up with Dekoron products — instrument-engineered by instrument engineers. A-9711A

Dekoron Metl-Cor installs in record time because it needs no straightening, bends readily... has no "low spots, moisture traps."

Lengths
TO 1000 FEET

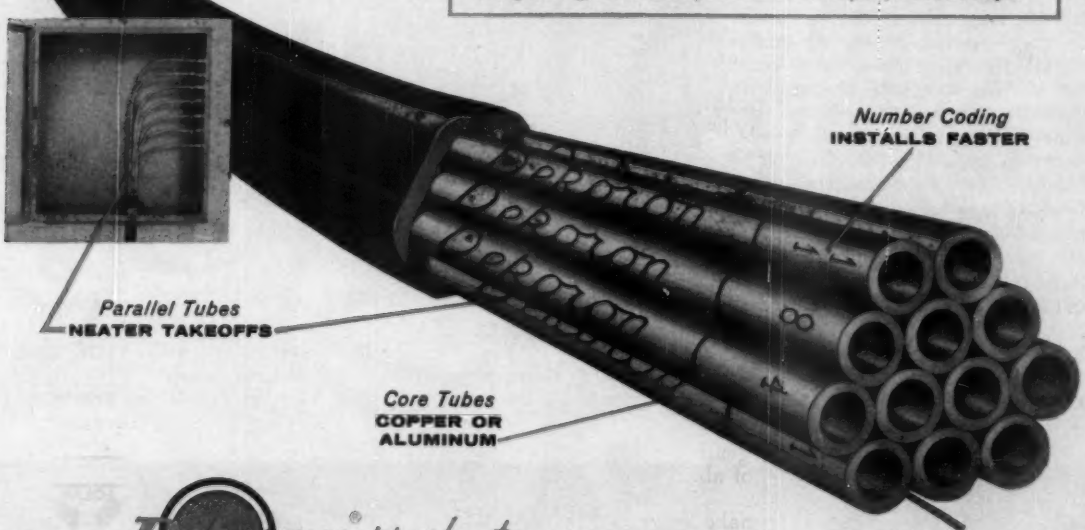
Greater Resiliency
IMPACT PROTECTION

Improved Polyethylene
GREATER CHEMICAL RESISTANCE

Number Coding
INSTALLS FASTER

Parallel Tubes
NEATER TAKEOFFS

Core Tubes
COPPER OR ALUMINUM



Dekoron® products

quality • research • service

SAMUEL MOORE & COMPANY • DEKORON PRODUCTS DIVISION • **MANTUA, OHIO**

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SARCO

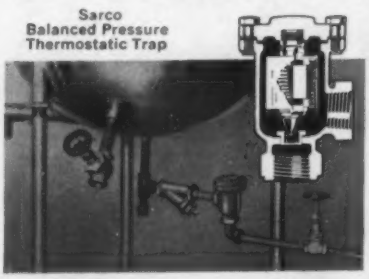
NOW... MATCH STEAM TRAPS

THERE'S no such thing as an all-purpose steam trap. That's why it pays to know what each trap has to offer. Here are five examples that demonstrate how you can match the correct steam trap type to the exact requirements of *each* application.

EXAMPLE 1: Outside Tracer Lines: A tough set of requirements

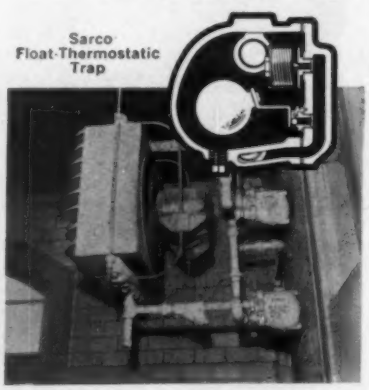
One of the most demanding sets of requirements a steam trap has to face is found in *outside steam tracing*. The trap must not only rid tracer lines of condensate and air immediately they're formed, but it must do so under exacting conditions. Pressures on each trap may vary widely. Installations may be remote and inaccessible to service. Water hammer may be a constant threat; freezing may be a hazard. Only the unique Thermo-Dynamic trap takes all these demands in stride. The Sarco TD-50 operates perfectly *without adjustment* through its full pressure range of 10-600 psi. It's virtually immune to water hammer and won't freeze when installed with a free discharge. Maintenance is, therefore, negligible. Compact, requiring no external support, the TD-50 is just about the easiest trap in the world to install. Once it's installed, you can forget it. You can count on an extremely long, trouble-free service life with minimum maintenance attention.

More closely than any other model, the TD-50 approximates an all-purpose trap. However, special application requirements might dictate the use of another type of Sarco trap. Sarco engineers stand ready to help you solve any trapping problems.



EXAMPLE 2: For steam jacketed process kettles: a trap that operates immediately on start-up and self adjusts to both low and high pressures

When a large steam-jacketed process kettle starts up, the condensate load is high, and all air in the jacket must be released quickly. At this stage, however, the jacket pressure is low; yet it builds up rapidly as the process continues. Because a SARCO No. 9 Balanced Pressure Thermostatic Trap is wide open on start-up, it releases initial air and condensate without the need for a bypass. And because it is self-adjusting, it works just as efficiently during the first processing stage when the jacket pressure is high. There are no seats to change for various working pressures. You can see why it is the obvious choice for steam jacketed process kettles.



EXAMPLE 3: How to prevent water-logging in unit heaters and blast coils

All unit heaters and blast coils have a relatively small internal volume in comparison with their steam condensing capacity. Even slight water-logging can reduce heat output seri-

Impartial advice on trapping because
ONLY SARCO MAKES ALL 5 STEAM TRAP TYPES

TOPICS

TO YOUR TRAPPING NEEDS

ously. Pressures may vary widely under automatic temperature control and so may the load because of variable demand. A trap to handle this application must adjust itself instantly to pressure and load charges. The most precise answer to this problem is the SARCO Float and Thermostatic Trap—and here's why: it releases air on start-up and during running, and, because it discharges condensate continuously, it does not set up in the system violent pressure changes that would upset close control.

Sarco Liquid Expansion Trap

EXAMPLE 4: How to release low temperature condensate

When condensate cannot be returned to the boiler feed tank either because of distance or because it may be contaminated, it's economical to utilize some of the sensible heat as well as the latent heat of the steam.

For this purpose a trap must be capable of releasing condensate to temperatures as low as 100° F.

The sound trap selection here is the SARCO No. 871 Liquid Expansion Trap because it can be set to release condensate at temperatures down to 100° F. regardless of supply pressure. This performance assures maximum steam economy. The Sarco No. 871 handles the starting load easily because of its wide open valve, which throttles the flow as the condensate temperature rises. Furthermore waterhammer cannot reach the operating element. No other type is as nearly perfect for this specific problem.

Sarco Bucket Trap

EXAMPLE 5: Economic handling of Water Hammer and Corrosive Conditions

In applications in which water hammer or corrosive conditions are encountered but in which low pressures or extremely high back pressures preclude the use of the Thermo-Dynamic trap, the Sarco Inverted Bucket Trap is recommended. While the Sarco I. B. is not exactly a fuel miser, its relatively rugged construction will withstand considerable water hammer; and, when it is fitted with stainless steel internal parts, it offers excellent resistance to corrosion.

* * *

CONCLUSION: The right application is the economical installation

When you choose steam traps that serve their purpose without frequent adjustment, and without maintenance or replacement problems, you save on down-time, man-hours, spare parts, and production slowdowns.

You can get the money-saving solution to every trap selection problem by consulting Sarco. You get impartial solutions, because only Sarco makes all 5 types of steam traps: Thermo-Dynamic*, Thermostatic, Float Thermostatic, Liquid Expansion, and Bucket.

You also get the benefit of Sarco's 50 years of specialized experience in the manufacture and application of temperature regulators, industrial air vents, pipeline strainers, dial and industrial thermometers, heating and cooling controls, heat exchangers, heating control systems and heating specialties.

For literature or impartial help in solving your steam trapping or control problems, contact your local Sarco Sales Representative, or write direct to Sarco. 1440

*U.S. Pat. No. 2,817,353, T.M. Reg. U.S. Pat. Off.

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

For more data circle 515 on Post Card

For fuses with 200,000 ampere interrupting capacity...

***plus,* extreme current-limitation**

plus,* time-lag to prevent needless blows – *you need . . .

Buss LOW-PEAK fuses

A Revolutionary New Protective Device

Buss LOW-PEAK Fuses are designed to meet modern demands for electrical protection.

They safely interrupt fault currents up to 200,000 amperes . . . limit let-thru current to exceptionally low values . . . and hold 500% load for minimum of ten seconds.

Protect Mains, Feeders, Branch Circuits, Motors, Controllers, Switches—no matter whether the fault current is 1,000 amperes, 25,000, 100,000—or as high as 200,000 amperes.

Reduce stresses and prevent damage to Panelboards, Switches, Motor Controllers—other circuit components—because let-thru fault currents are limited to exceptionally low values.

Can be easily co-ordinated into a selective system—to limit fault outages to circuit of origin.

Prevent work stoppages, lights out, waste of time and money—because long time-lag keeps them from opening needlessly on motor starting currents or other harmless overloads.

Permit increasing interrupting capacity and current limitation on present electrical system at minimum cost. Buss LOW-PEAK Fuses fit standard switches and panelboards. Available from 15 to 600 amperes in both 250 and 600 volt ranges.

Guard motors against burnout from single phasing and overloads.

Low operating temperature reduces heating in switches and panels.

Provide thermal protection for equipment against damage due to poor contact.

Protect against waste of space and money by permitting the use of proper size switches and panels.

Remain safe throughout the years without maintenance or recalibration.

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Write for Buss LOW-PEAK Bulletin Now . . . or use coupon.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co.
St. Louis 7, Mo.

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Please send Buss LOW-PEAK Fuse Bulletin LPCS.

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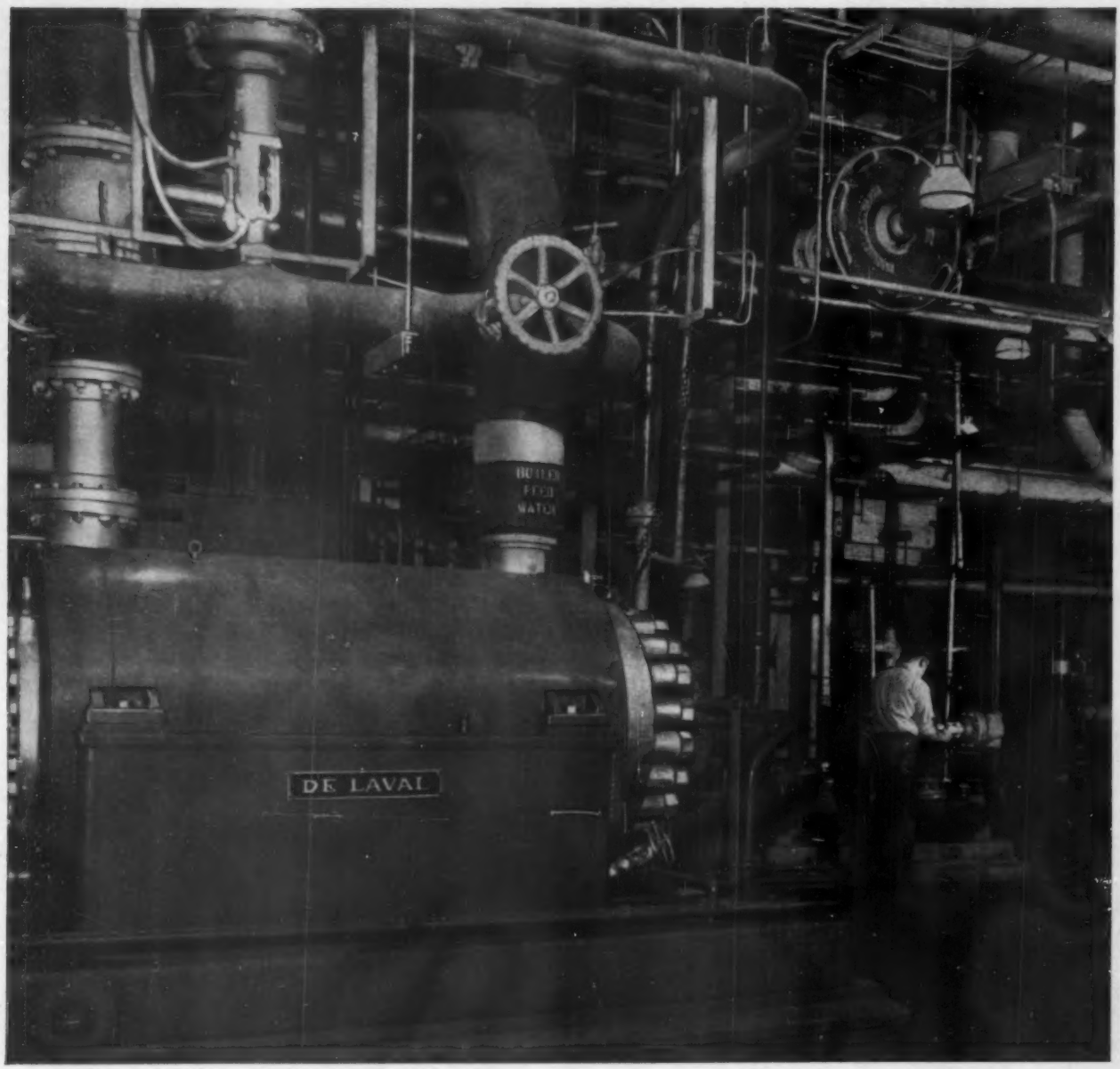
DE LAVAL Boiler Feed Pumps part of modernization



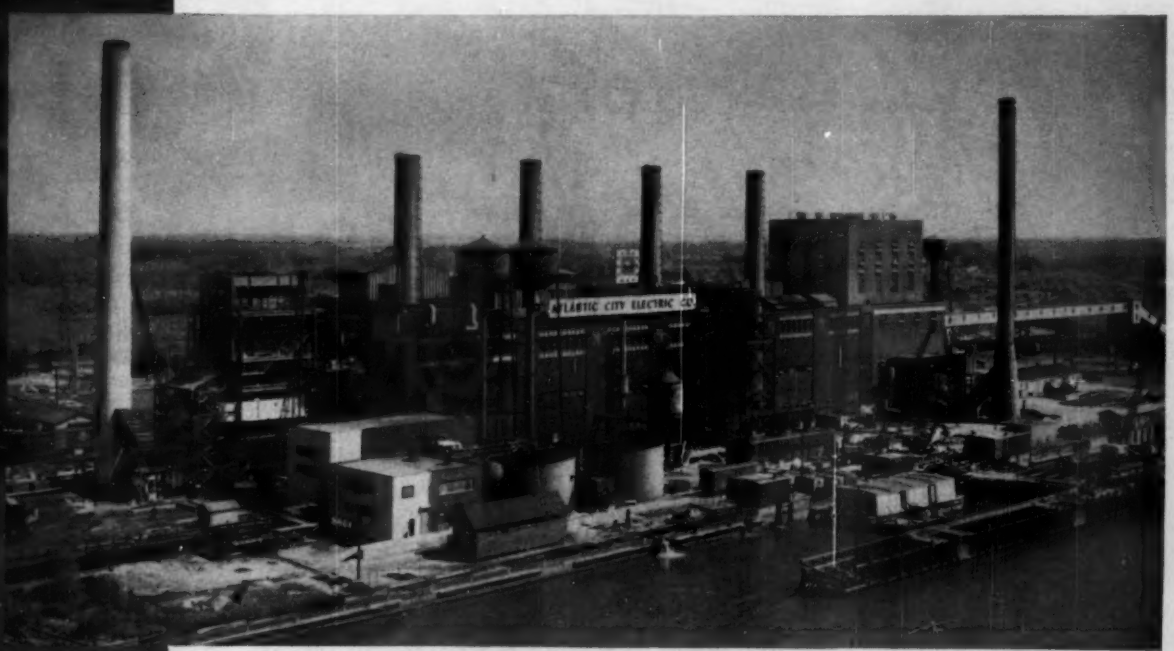
Each De Laval pump has intermediate pressure bleed off for use in controlling steam temperature from reheater.

at Atlantic City Electric

Gibbs & Hill, Inc., Consulting Engineers, handled project for new 79,000 KW unit

To meet increased load demand while improving station performance, Atlantic City Electric has completed the installation of a new 79,000 KW No. 1 main unit at Deepwater Station, the largest now operating in their system.

Providing dependable boiler feed service are two 1000 HP direct motor driven half capacity De Laval barrel feed pumps, now in their second year of operation. This is the second modern installation at Deepwater to be served by De Laval barrel pumps.



Deepwater Station at the southern extremity of the N. J. Turnpike.

DE LAVAL STEAM TURBINE COMPANY
816 NOTTINGHAM WAY, TRENTON 2, N. J.

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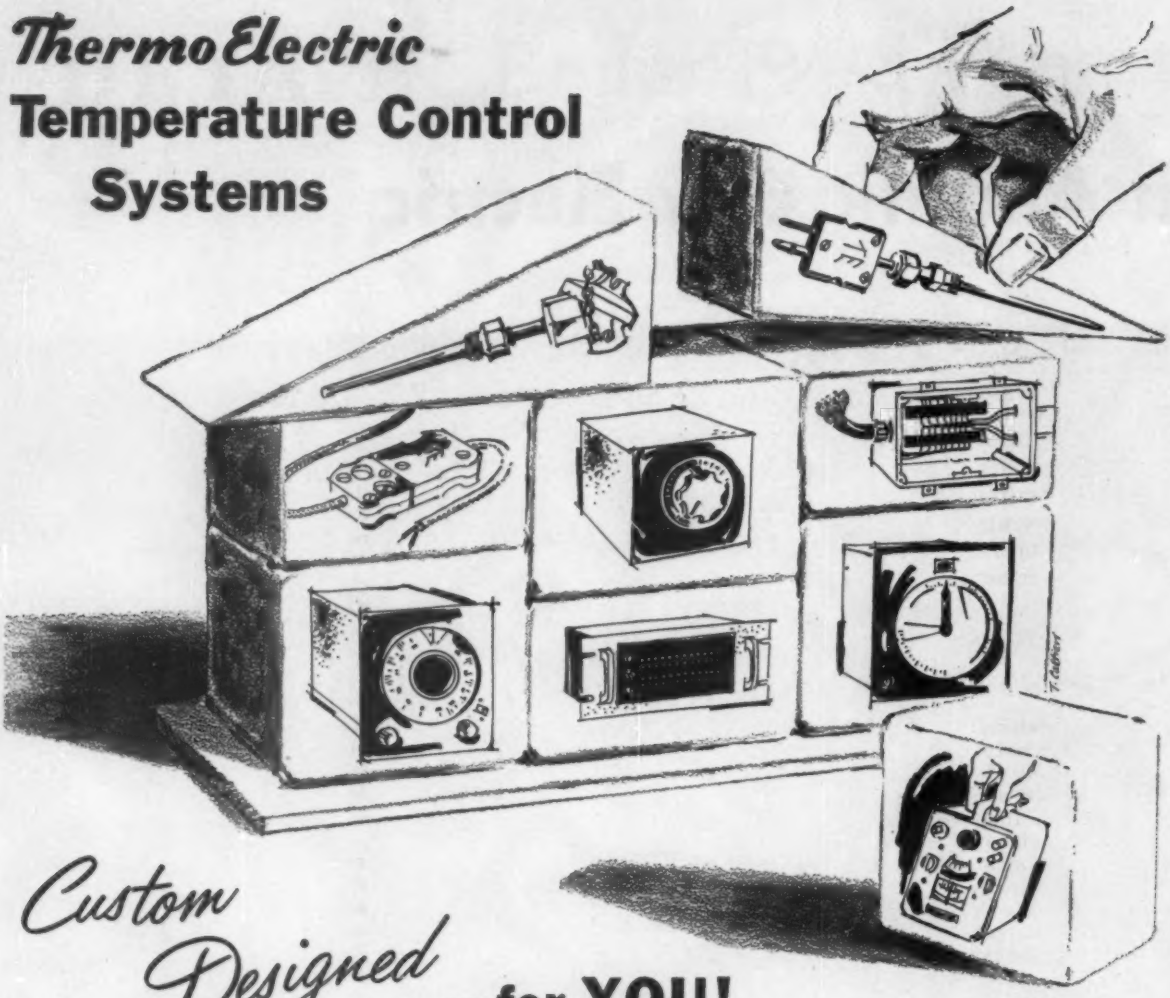
Thermo Electric Temperature Control Systems



Custom Designed — for YOU!

Thermo Electric advanced systems-building components permit custom designing to satisfy your temperature monitoring, indicating, recording, or controlling requirements, exactly and economically. Starting with T. E. thermocouples—standard or special calibrations—from 1 inch to 66 feet and longer, accessories are carefully selected by T. E. applications engineers to relay any number of signals to your instrument panel. Quick-coupling plug and jack connectors and panels, extension wire and cable are precisely matched to eliminate false emf's. Junction boxes, rotary, key or push-button selector switches are all designed and constructed by T. E. to the highest quality standards.

To monitor, indicate, record or control process variables, T. E. offers the compact Signaling Controller—the Indicating Controller and Indicating Recorder with large, easily-read scales, or special multi-point monitor systems. All instruments have front-set controls, complete in-the-field range interchangeability, ease of service, and feature the new High Gain Relay or Servo Amplifiers with high sensitivity and exceptional stability.

The portable "MiniMite" Indicator with 23" scale and 0.25% scale accuracy, can be used to indicate on-the-spot temperature or for calibration and test work.

Let us assist in building your process control system.

Send application details on your letterhead today to Dept. 21

Thermo Electric CO., INC. SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ontario

Hall Industrial Water Report

VOLUME 8 OCTOBER 1960 NUMBER 5

How to Avoid Crash Programs

What caused your latest emergency crash program? Was water at the bottom of it? Did boiler tubes fail because of internal deposits or corrosion? Power plant down to clean turbine blades? Steam heat cut off for repair of leaking return lines? Air conditioning equipment shut down to clean condensers? Process gone sour due to poor clarification of water? In trouble with state authorities over contaminated waste water?

Crash programs to maintain production or to minimize losses caused by shutdowns for repairs or changes to improve water conditions are costly. They can be avoided if suitable water treating equipment is installed and effective water conditioning programs are adopted.

Hall Laboratories engineers are specialists. They can advise on equipment and set up water conditioning programs designed to give you trouble-free operation at low cost. And they can teach your operating men how to maintain the proper water conditions.

Stripper Column Deposits

During a routine boiler water conditioning service call at a New Jersey chemical plant Hall field engineer Frank Duesing spoke of plant-wide water service. Immediately, a plant chemical engineer suggested that Duesing look at a solvent recovery stripper column which was out of service because of heavy deposits on the bubble plates. The plant engineers had assumed that the deposits were composed of material picked up by the solvent and precipitated in the recovery equipment.

Duesing tested the deposit in dilute acid. The rapid evolution of carbon dioxide gas indicated that the material was made up largely of calcium carbonate. This meant that the hard raw water being used was responsible for the deposition. Duesing recommended acid cleaning of the column and substitution of zeolite-softened water, or preferably condensate, for the raw water. Zeolite-softened water was immediately available so this was used.

There has been no further deposition of calcium carbonate, although a little temporary trouble occurred when the solvent did become contaminated with catalyst. The previous experience led to quick identification of the material so that plant engineers could promptly stop the contamination.

Flood Causes Water Shortage

When floods produced a break in the dam of the municipal reservoir at a city in Ohio, all industrial city water users had to curtail consumption. A box company immediately made plans to keep their boiler operating by bringing water in tank trucks from a neighboring city. Unfortunately, there was no time to clean the tanks which had been transporting oil and salt water.

Hall field engineer Dale Holland arrived at the plant just before use of the contaminated water was started. After quickly analyzing the purchased water he set up a program of hourly testing, blowdown control and antifoam feed. He then helped the operators maintain good control during the emergency period. The quick action permitted trouble-free operation of the boiler despite oil contamination, harder water and abnormally high solids concentrations.

One of the plant operating men remarked that, in his opinion, no plant production would have been possible during the emergency without the help given by the Hall Laboratories engineer.

Deaerating Heater Trouble

Despite repeated recommendations of Hall field engineer Stan Ziarkowski to use sodium sulfite to protect the boilers from corrosion, the operators in an industrial plant did not get around to installing the necessary feeding equipment. There seemed to be no urgency because the boilers had operated for a long time without corrosion damage.

When Ziarkowski inspected the largest boiler, and found some pitting his concern grew. The situation was serious because this boiler was the only one which could carry the entire plant steam load. His concern increased when feedwater tests showed the concentration of dissolved oxygen to be much higher than normal for a deaerating heater.

The heater was inspected and cleaned. Nothing to account for poor deaeration could be found so it was put back in service. Again feedwater oxygen tests showed excessive concentrations. Another inspection was made at Ziarkowski's request and this time the vent condenser was opened. Here was the trouble. Many tubes were leaking, permitting water to pass through the heater without being thoroughly deaerated.

Vent condenser tubes were repaired. The use of sodium sulfite was started. Then all ran smoothly. What seemed to be an unnecessary move could have saved the replacement of more than one hundred fifty pitted boiler tubes and avoided production downtime.

Water is your industry's most important raw material. Use it wisely.

How Consultants Solve Industrial Water Problems

There are no "stock answers" to industrial water problems. A new 24-page booklet, "Hall Laboratories—Industrial Water Consultants," describes the many ways industry can use water most economically. For a copy of this booklet, write on your letterhead to:

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

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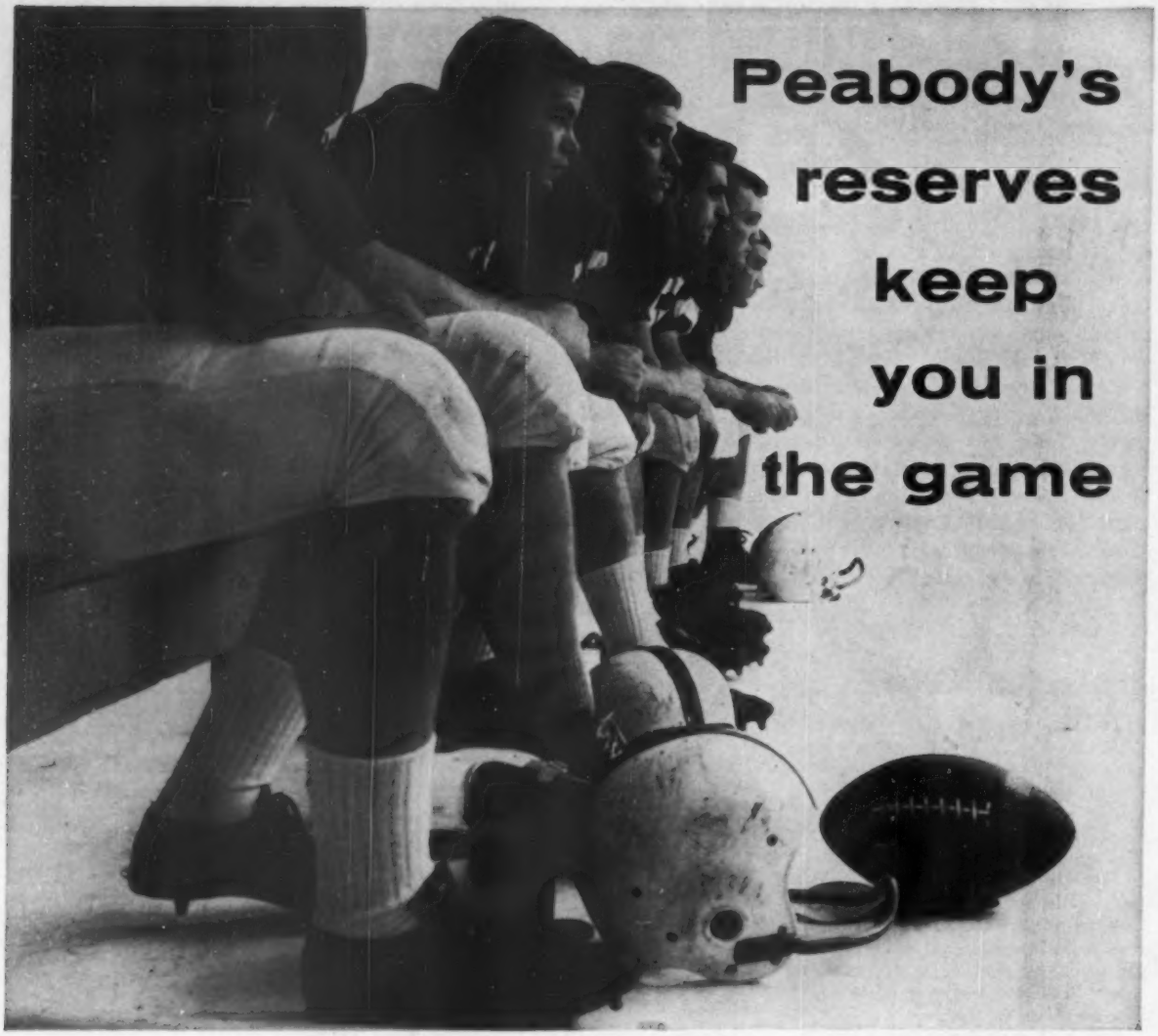

Over Two Billion Tons Of Proven Reserves Assure You An Abundant Coal Supply Far Into The Future!

High productivity takes *Power*—and *plenty of it*—the kind of long-range power made possible by *Peabody's two billion tons of proven coal reserves.* This vast fuel reservoir . . . large enough to light and power the city of Chicago for 200 years . . . can be a dependable source of power for your Company in the years ahead. Peabody's continuous development of productive mining properties . . . economically accessible to the nation's inland waterways and rail facilities . . . assures you of long-term availability and diversified selection.

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Current Catalogs

Boilers and Burners

101 Scotch Marine Boiler — Design and construction features of Eclipse Boiler Div.'s automatic horizontal three-pass Scotch Marine boilers are illustrated and described in Bulletin A-104-3. Detailed specifications are included, as well as description of sequence of operation.

102 Forced Draft Boilers — Bulletin 149D, 12, pp, on Kewanee forced-draft Scotch type packaged boilers for high and low pressure industrial and commercial applications, is available from American-Standard Industrial Div. These boilers can be fired with natural gas, fuel oil or combination gas/oil. Illustrated with photos and line drawings, bulletin gives ratings, dimensions and technical data.

103 Fuel Burning Systems — Features and operation of fuel burning systems for oil, gas or combination oil/gas fuels are detailed by Orr & Sembower, Inc., in 8-pp Bulletin 1270. Typical burner arrangements are illustrated.

Valves, Traps, Piping and Fittings

104 Bronze Valves — Eight-pp Catalog 60, released by American Valve Mfg. Co., describes bronze valves, including screw end or sweat end gate valves with O-ring or conventional packing, renewable disc or standard brass seat screw end globe valves, screw end or copper-to-copper compression stops and valves, and a wide variety of gas cocks, check valves, radiator valves, and balancing elbows.

105 Ball Valves — Thermoplastic ball valves of unplasticized polyvinyl chloride and Penton are described by Tube Turns Plastics, Inc., in Bulletin TTP-180. Design features and corrosion-resistance characteristics are detailed.

106 Corrosion-Resistant Valves — Bulletin V-4b describes corrosion resisting valves with Teflon sleeves manufactured by The Duriron Co., Inc. Details of construction are illustrated and valve dimensions and other data tabulated.

107 Air Control Valves — This 40-pp illustrated specification catalog of Hoffman-Odom Co. covers Inline two-, three-, and four-way valves and sub-base mounted four-way and four-way five-port valves. Features valve selection tables and parts tables, cutaway drawings showing design and construction. Includes information on installation and maintenance, and on conversion to external pilot supply.

108 Steam Traps — In this 1960 Condensed Catalog of Sarco Co., Inc., are 12 pp of technical details, dimensions, and capacity data on steam traps, temperature regulators, and heating specialties. Cutaway views and diagrams are included.

109 Power Piping Erection — Field erection of high-temperature, high-pressure power piping is the topic of this 12-pp bulletin released by The M. W. Kellogg Co. Illustrated with photos and diagrams, it shows how detailed plans are developed, field-erection costs and quality controlled, welding and other technical aspects.

110 Transite Underdrain Pipe — Bulletin TR-246A offered by Johns-Manville describes use of Transite underdrain pipe in subsurface drainage systems. Advantages and economies are detailed, and installation and assembly illustrations included.

111 Non-Corrosive Drainline — This 20-pp engineering and parts catalog describes Vulcathene, a permanent acid and corrosion resistant waste and drainage system of plastic plumbing equipment manufactured by The Nalge Co. Includes section on Polyfusion method of joining pipe and fittings, and gives technical and dimensional data.

112 Tube Fittings — This 118-pp catalog contains comprehensive information on company's tube fittings, including the O-ring seal fittings. Each specification table is coupled with a large, close to actual size cutaway drawing with all dimensions on illustration keyed to specifications and dimensions table. It is available from The Lenz Co. to qualified engineers. Please state your title.

113 Flexible Tubing Facts — Catalog 10-19 deals with flexible tubing — nonmetallic tube and duct for handling air, liquids and light solids. Prepared by Flexible Tubing Corp., the brochure discusses briefly the product's varied forms, its major advantages and uses.

Heating and Cooling

114 How Much for Heat? — For determining heating costs and savings, this calculator, offered by Wanson Corp., is an easy-to-read slide rule covering use of Thermobloc direct fired warm air heaters. You merely determine the square foot area of your plant and locate that figure on the rule. You can then read the number and size of heaters needed, and dollar savings realized by using these heaters.

115 Air Intake Units — Gas and steam fired air intake units and unit heaters are featured in 12-pp Bulletin A-117 published by Hartzell Propeller Fan Co. Includes construction and control details, performance data and dimensions.

116 Heat Exchangers — Illustrated and described in Bulletin HE-260 are Bell & Gossett Co.'s heat exchangers for heating and cooling a wide variety of fluids. Describes various heating and refrigeration components.

Mechanical Power Transmission

117 Variable Speed Drives — Details on multiple groove variable pitch sheaves are presented in 24-pp Catalog MVP-101 of Browning Mfg. Co. Detailed specification data, dimensions and diagrams are included.

118 Shaft-Mounted Reducers — Technical information on shaft-mounted geared speed reducers as well as illustrations, descriptions and selection data are presented in 12-pp Form F-2003 issued by U. S. Electrical Motors Inc. Tables are included showing service classifications to be applied in determining types of speed reducers for industrial and other applications.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 115 and 116.

119 Timing Belt Drives — Described in T. B. Wood's Sons Co. 8-pp Bulletin 21103 is a method of selecting timing belt drives involving a minimum of mathematics. Includes five sets of curves for drive-width selection, designed to eliminate computation.

120 Narrow Sheave Drives — Advantages of Maurey Mfg. Corp's narrow sheave drives are detailed in 24-pp Catalog SW-1. Includes selection and installation data, drive selection tables, horsepower ratings, sheave dimension tables.

121 Worm Gear Drives — Engineering Catalog HGB contains comprehensive information on enclosed worm gear drives, manufactured by Foote Bros. Gear and Machine Corp. Features simplified selection procedures and rating tables, enabling quick and accurate identification of drive to meet specific requirement.

122 Differential Reducers — Detailed information by Winsmith, Inc., on horizontal motorized differential speed reducers is presented in 16-pp Catalog HM-60. Contains engineering data, mounting information, service factors, horsepower, torque and overhung load ratings.

123 Tailored Torque — Illustrated in color, Form P-78, 8-pp, of Warner Electric Brake & Clutch Co., explains company's electric operating principle. Describes several clutch, brake, and clutch-brake applications, outlines specific operating advantages, and includes torque ratings and package dimensions for the product line.

124 Heavy Duty Pillow Blocks — Full information on heavy duty pillow blocks with self-aligning spherical roller bearings in split housings is provided in 20-pp Catalog 860 of The Torrington Co. Design features of the line are discussed and illustrated and dimensions included. Booklet also gives special information on bearing selection, prediction of bearing life, lubrication, installation.

Construction, Maintenance

125 Steel Grating — Design features and advantages of Kerrigan Iron Works Co.'s electronically welded steel grating and treads are detailed in this 12-pp bulletin. Engineering data includes tables of safe loads, weights, conversion factors, and specifications.

126 Metal Flooring — Steel and aluminum flooring and stair tread are illus-

trated and described in 12-pp Bulletin 50–9, released by Joseph T. Ryerson & Son, Inc. Both solid and open types are covered, and plate and panel sizes, tables of safe loads, and design, specification and installation data included.

127 Preventive Roof Maintenance — Case History R-25 of Tremco Mfg. Co. details a preventive roof maintenance program and its economies. Illustrates actual methods used in surveying roof, recommended budgeting for major long-range protection, and cost reduction benefits.

Electrical

128 Dry-Type Transformers — Features which contribute to speedy installation of small, light dry-type transformers are illustrated and described by Allis-Chalmers Mfg. Co. in Bulletin 61B8222B. Dimensional diagrams and data are included.

129 Switch, Fuse Equipment — Eight-pp Bulletin GEA-6623B, General Electric Co., describes redesigned switch and fuse equipment, incorporating rollout feature for easy maintenance. Illustrated with photos, cutaways, diagrams and tables, bulletin gives maintenance and installation information.

130 Metal-Clad Switchgear — Comprehensive information on I-T-E Circuit Breaker Co.'s stored energy metal-clad switchgear is presented in 20-pp Bulletin 2801-2A. Construction and performance features, ratings and dimensions are included, as well as photos, sketches, diagrams, charts and tables.

131 Electrical Operators — Booklet B-7534, Westinghouse Electric Corp., tells how to apply electrical operators for the remote control of circuit breakers. Electrical operator dimensions are given and typical applications are shown.

132 High-Frequency Bus Duct — Detailed information on high-frequency bus duct manufactured by Westinghouse Electric Corp. is contained in 12-pp Application Data 30–663. Descriptions, drawings, dimensions, specifications and engineering and test data included.

133 Rigid Aluminum Conduit — Data on rigid aluminum electrical conduit is assembled by Kaiser Aluminum & Chemical Sales, Inc. in this 32-pp manual. Physical properties and performance factors of rigid aluminum conduit are compared to steel conduit in indexed charts, tables and text.

134 Metal Raceways, Fittings — Catalog and Wiring Guide 22 issued by The Wiremold Co. contains 152 pp of data on surface metal raceways and fittings, multi-outlet assemblies, and lighting equipment. Included is a section on National Electrical Code as it affects company's products including tables of capacities, as well as installation and application information and installation photos.

135 Magnetic Level Switches — Detailed information on basic types of magnetic level switches manufactured by Bestobell (Canada) Ltd. is presented in 34-pp Bulletin MC211/5709. Includes construction and operation details, drawings of typical installations, wiring diagrams.

136 Electrical Insulating Oils — Bulletin 58, 6 pp, gives technical information on Sun Oil Co.'s insulating oils for transformers and cables. Discusses functions of a transformer oil; gassing characteristics of oils, properties of electrical oils, uses for inhibited and uninhibited oils. Information on cable oils includes discussion of requirements of three basic types of cables; viscosity-temperature relationships of cable oils; oxidation stability.

137 Motor Insulation Systems — Technical details on Elliott Co.'s epoxy insulation system for motors are presented in Bulletin PB 6000–12. Random wound and form wound motors are illustrated.

138 For Corrosive Locations — Twenty-pp Bulletin 2699 describes condulets manufactured by Crouse Hinds Co. for corrosive locations. Corrosive substances are listed in tabular form with appropriate corrosion-resistant metals and finishes used in the condulets.

Water Management

139 Water Treatment — Process Bulletin C2, released by Nalco Chemical Co., describes a comprehensive method for treating and protecting recirculating water equipment and process water systems. Application methods are described.

Catalogs reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

140 Corrosion Control — Methods used in steam-condensate systems for control of corrosion are described in Process Bulletin B-6 from Nalco Chemical Co. It covers use of filming corrosion inhibitors and neutralizing amines for low, medium and high makeup systems. Illustrations show how the inhibitors form a protective film and the amines neutralize CO_2.

141 Water, Waste Treatment — Methods and equipment for treating metal finishing process water and wastes are covered in Technical Reprint T-180 released by Graver Water Conditioning Co. Discusses reasons for treatment, how to investigate problem, modern treatment methods for hexavalent chromium, cyanides, acids and alkalies, oily wastes and process water.

142 Sludge Remover — Twelve-pp Bulletin 315–81, Chain Belt Co., describes features and advantages of the Rex Unitube Tow-Bro remover for industrial and municipal use. Explains principle of sludge removal through suction action and includes photos of typical installations.

143 Poly-Metallic Cooling Systems — Effects of utilizing dissimilar metals in cooling systems and a discussion of what causes galvanic corrosion are covered by Nalco Chemical Co. in 10-pp Reprint 91. Points up problems associated with poly-metallic closed and open-recirculating cooling systems and recommends type of corrosion inhibitors designed for optimum protection of metals.

144 Water Treating Instrumentation — Discussed in 28-pp Bulletin B96–2 of Minneapolis-Honeywell Regulator Co. is instrumentation for treatment of industrial water. Describes typical water treating systems used in processing.

Instruments and Controls

145 Supervisory Equipment — Eight-pp Bulletin GEA-7043 describes features, dimensions and operating characteristics of General Electric Co.'s solid-state supervisory control equipment. Contains photos, drawings and diagrams of the equipment which uses solid-state components to provide low-cost centralized operation, indication and telemetering of remote apparatus.

146 Computer Control, Monitor — Illustrated and described in this 10-pp bulletin of The Thompson-Ramo Wooldridge Products Co. is computer control and monitoring for electric power systems. Describes a typical control and monitoring system with company's RW-300 digital control computer as the central unit.

147 Meters, Feeders, Controls — Featured in 8-pp Bulletin 0001.20–1 are meters, feeders and controls manufactured by B-I-F Industries, Inc. Among instruments described are butterfly valves, supervisory control systems, totalizing meters, water and waste treatment equipment and systems, flow meters, process instrumentation, feeders for solids and liquids and blenders for liquids.

148 Magnetic Gages — Six-pp Catalog 388 covers features, models, construction data and operation of magnetic gages for liquid level. Produced by Jerguson Gage & Valve Co., these gages are desiged for use where glass and its gaskets cannot be tolerated and where a sealed container for liquid is preferable.

149 Automatic Combustion Control — In Bulletin E-104, Reliance Instrument Mfg. Corp. describes automatic combustion controls for oil, gas or coal fired boilers. Features and advantages of various types of controls for economic steam generation are outlined.

150 Timers and Counters — Condensed Catalog D-31 contains 30 pp of reference data on automation components and control systems, covering latest timing components and linear measuring systems. Standard timers and counters are reviewed, as well as electronic timers, special timers, package control systems, test equipment, switches, controllers, contactors and valves, and other products of Automatic Timing & Controls, Inc.

Materials Handling

151 Tractors, Other Equipment — Illustrated and described in this product bulletin are industrial tractors and related equipment manufactured by J. I. Case Co. Covers tractor-shovels, power-angling dozers, power-tilting bulldozers, wheel loaders, fork lift, interchangeable attachments.

152 Car Retarder — Featured in this American Brake Shoe Co. product bulletin is a mechanical car retarder designed to bring rolling freight cars to a stop and resist further movement from impact of succeeding cars.

153 Deep Trough Idlers — Eight-pp Book 2716A released by Link Belt Co. con-

Continued on page 115

FOR EL PASO . . .

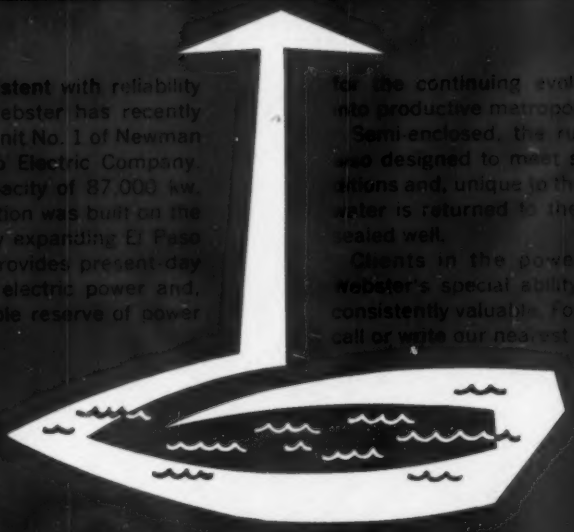
LOW COST RELIABILITY

At the lowest cost consistent with reliability requirements, Stone & Webster has recently designed and completed Unit No. 1 of Newman Power Station for El Paso Electric Company. This initial unit has a capacity of 87,000 kw.

The Newman Power Station was built on the desert north of the rapidly expanding El Paso community. This station provides present-day El Paso with dependable electric power and, for the future, a dependable reserve of power for the continuing evolution of desert lands into productive metropolitan areas.

Semi-enclosed, the rugged Newman unit is also designed to meet severe sandstorm conditions and, unique to the site, deepwell cooling water is returned to the earth via a 1,200 ft. sealed well.

Clients in the power field find Stone & Webster's special ability and long experience consistently valuable. For complete information call or write our nearest office.



STONE & WEBSTER ENGINEERING CORPORATION

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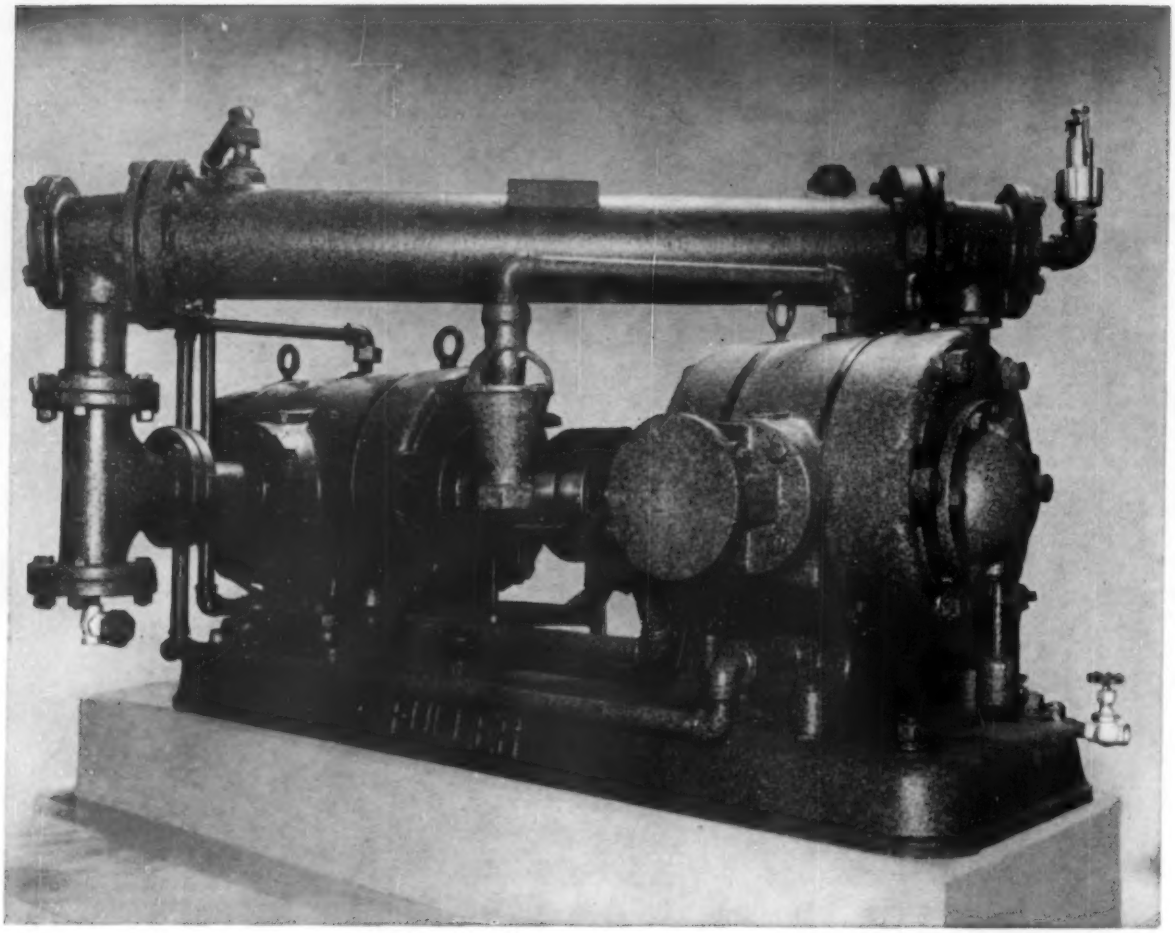

Fuller Compressors With Overhead Intercoolers Offer A New Dimension In Compactness

Fuller Rotary Two-Stage Compressors equipped with Overhead Intercoolers fill the bill where space may be a problem. These compressors produce from 30 to 3300 cfm, pressures to 125 lb. gage and can be readily installed.

These compact Rotary Compressors are vibration-free, thereby eliminating the need for involved and expensive foundations or structural modifications.

The Fuller rotary principle permits complete freedom of reciprocating parts—valves, crankshafts, pistons—cutting the need for frequent servicing and parts replacement. Minor maintenance is all the care indicated for years of serviceability.

For full details on the maintenance-free economy and high performance of Fuller rotaries, write today for comprehensive, illustrated Bulletin C-5A. 2626 C359

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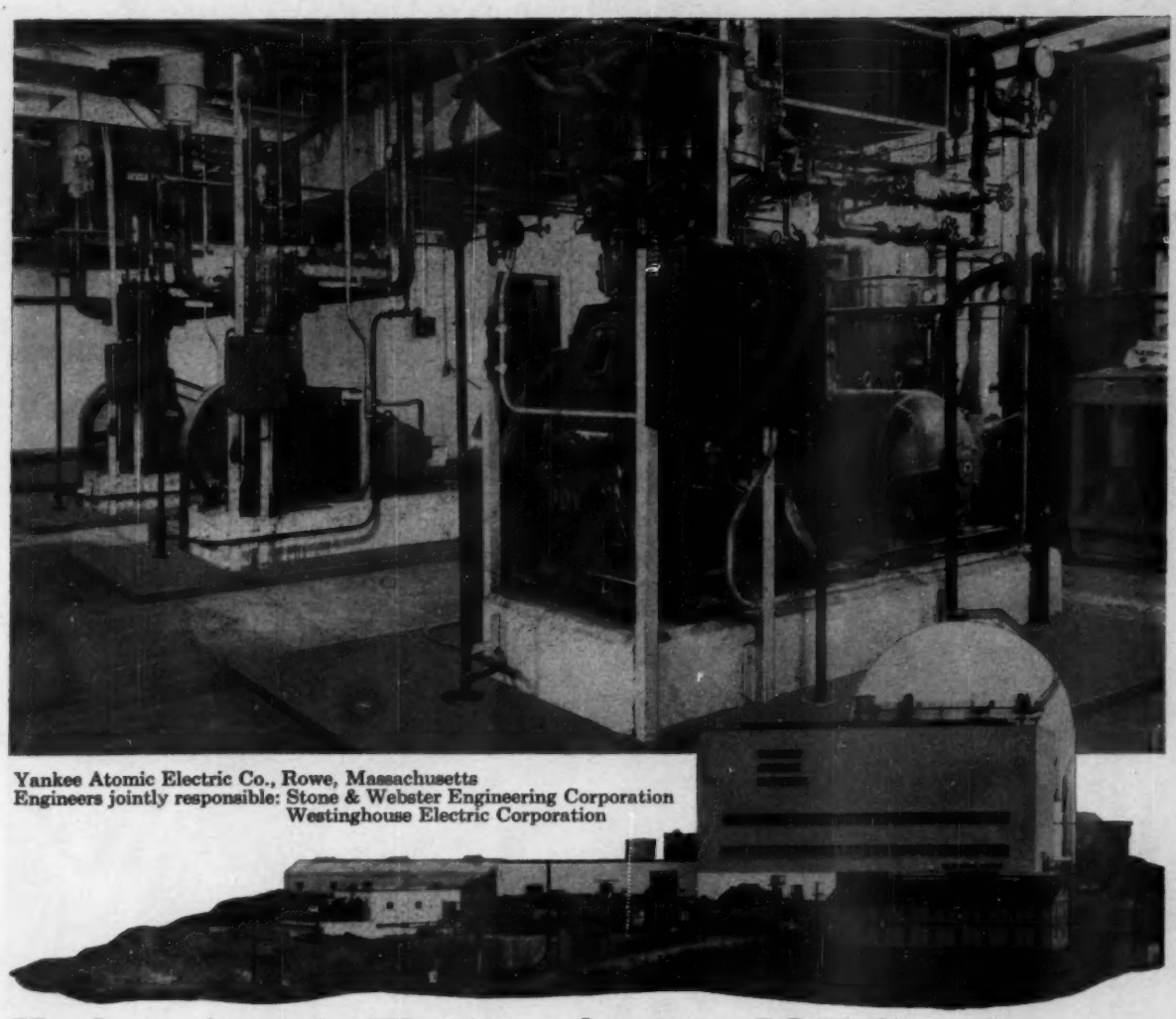

Yankee Atomic Electric Co., Rowe, Massachusetts
Engineers jointly responsible: Stone & Webster Engineering Corporation
Westinghouse Electric Corporation

Yankee Atomic Electric **chooses** JOY Compressors for New England's first Nuclear Power Plant

Compressed air requirements at the Yankee Atomic Electric plant are not large but vitally important. Reliability of all machinery is a must, once the reactor goes critical. Two Joy WGO-9 vertical compressors supply oil-free air for instruments and controls. Each machine produces 172 cfm at 100 psi and is V-belt driven by a 25 horsepower motor. Carbon graphite piston rings completely eliminate lubricating oil in the cylinders. The compact vertical design requires less than seven square feet of floor space for each installation.

General service air is supplied by a 100 hp Joy WG-9H compressor producing 769 cfm at 100 psi. This machine has the same space-saving vertical design in sizes up to 150 hp.

Joy compressors are chosen for many of the country's finest installations . . . there is a size and type for you, reciprocating, centrifugal or axial. For information, write for bulletin 1685-56C

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JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

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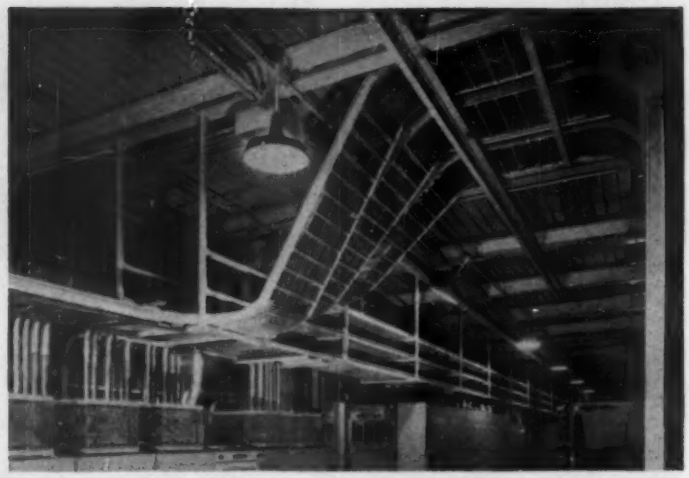
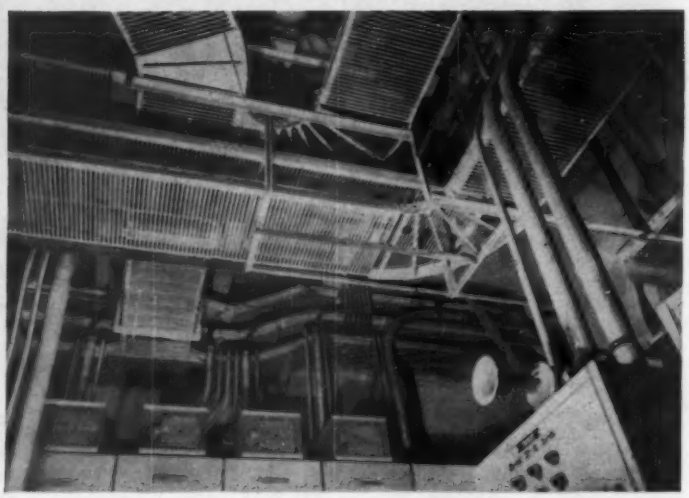
how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS to support cables in their Indiana Harbor Plant



★ Engineered for Uniform Design and Easy Installation
★ Steel or Aluminum Construction
★ Complete Accessories for SPEEDIER Installation
★ Complete Interchangeability
★ No Sharp Edges to Damage Cables



Globe's two types of cable trays, one a ladder type and the other a basket type, to support cables, wiring and tubing have become increasingly popular because they can be used INTERCHANGEABLY at any given location depending on the type and weight of the cables to be suspended. The advantages of each type tray can be used to the fullest. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is used for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants and for power distribution in all types of manufacturing processes. Send for FREE catalog giving full information and installation techniques.

PRODUCTS DIVISION
THE GLOBE COMPANY Manufacturers since 1914
4032 Princeton Ave., Chicago 9, Ill.

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THE NEW, TIGHT-CLOSING PRESSURE REDUCING VALVE THAT *CAN'T FOUL*

If you like a simple, straight-forward solution to vexing valve problems, you're bound to be impressed with the new line of Leslie-Topper Pressure Reducing Valves. To avoid valve fouling, Leslie Engineers developed a tight-closing valve with an internal pilot that's completely out of the path of steam—*it just can't foul.* Let imaginative engineering simplify valve design and you get results.

Here's the one pressure reducing valve that handles poor steam conditions, intermittent or standby service better than any other valve. It provides high accuracy of regulation with negligible dead-end build up and costs only pennies for maintenance.

New, patented Leslie-Spiroflex* all metal diaphragm insures years of outstanding valve performance. It makes a long valve stroke possible in a packless design—there's nothing to leak, nothing to bind. It's time for a change when you can get rid of the cost and bother of fussy, old-fashioned pressure regulators.

*Trademark of Leslie Co.

Leslie-Topper Selection Table

Size	Inlet Pressure PSI	Adjustable Pressure Range PSI	CLASS		
			Cast Iron Construction	Bronze Body Construction With Iron Superstructure Castings*	All Bronze Construction
½" TO 1¼"	UP TO 150	2 - 10	GKLL	GLL	GBLL
	OVER 125	2 - 10	GKL	GL	GBL
	UP TO MAXIMUM BODY RATING	5 - 20	GKM	GM	GBM
		15 - 35	GKH	GH	GBH
1½" TO 2"		2 - 10	GKL	GL	GBL
		5 - 20	GKM	GM	GBM
	UP TO 150	5 - 35	GKHL	GHL	GBHL

*All parts in contact with controlled fluid are of bronze.

For sizing and capacity data write for Bulletin 582 or contact your Leslie Engineer—he's listed in the Yellow Pages under 'Valves' or 'Regulators'.

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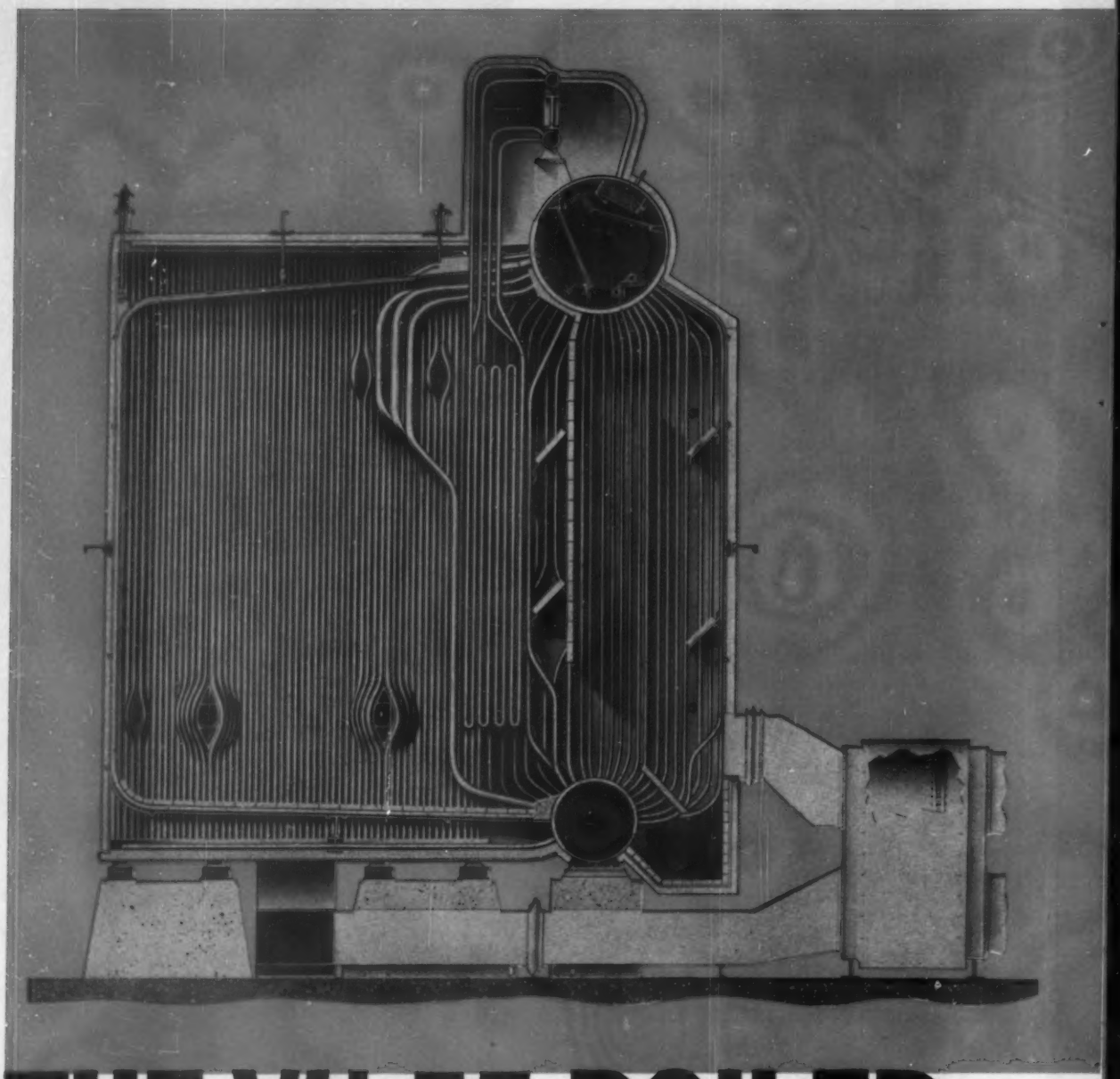


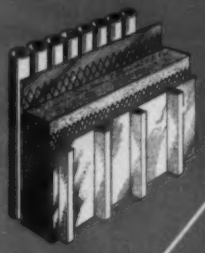
THE VU-55 BOILER...

The C-E Vertical-Unit Boiler, Type VU-55, is designed to bring central station type of performance to the "standardized" boiler market.

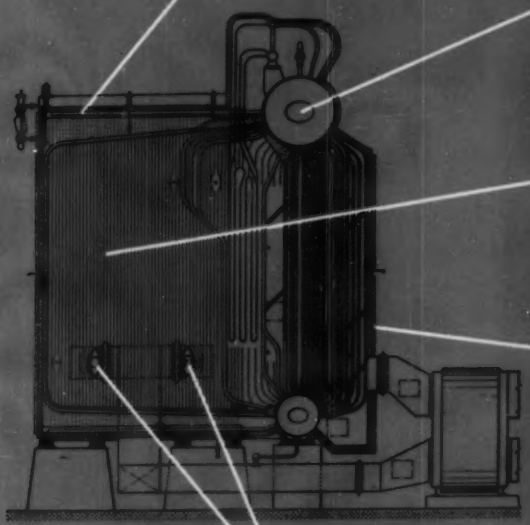
It combines a number of time-tested and service-proved features such as Tangential Burners, pressure-tight casing and tangent furnace tubes. This bottom-supported unit requires no outside supporting steel, is economical of space and has an uncluttered, streamlined appearance.

The VU-55 is available from 70,000 to 150,000 lb of steam per hour. It is designed for three pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 800 F.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



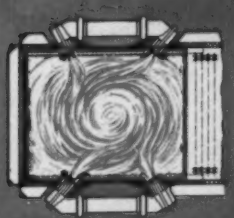
PRESSURE-TIGHT, SKIN CASING. A service-proved method of casing construction for pressure-fired boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Wall construction consists of tangent tubes backed up successively with welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and to give a neat, finished appearance.



HIGH STEAM QUALITY. The VU-55 has generous water capacity and steam reservoir space. Its drum internals are exceptionally effective in producing high quality steam at all ratings.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated.

STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

a "standardized" boiler with "custom-built" performance

The unit is symmetrical in design, performs efficiently over a wide range of output, and is exceptionally easy to operate and maintain.

When you are considering additional steam capacity in the quantity range mentioned above don't fail to investigate the advantages of the VU-55.

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C-E

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PRESSURE REDUCING VALVE SELECTION CHART								
	700	710	715	720S	720W	740	750	758
SIZE—Inches	⅛–8″	⅛–1½″	2–4″	¾–6″	¾–6″	⅛–8″	⅛–1″	¼–½″
MAX. INITIAL PRES. PSI	200	250	250	250	250	250	250	300
MAX. REDUCED PRES. PSI	15	80	125	125	15	125	125	180
MIN. REDUCED PRES. PSI	1	5	5	15	2	5	2.5	5
STEAM SERVICE	■	■	■	■	■		■	
WATER SERVICE		■				■	*	■
AIR SERVICE		■	■	■	■	■	*	■
GAS SERVICE		■	■			■		■
OIL SERVICE		■	■				■	
SINGLE SEATED		■	■	■	■	■	■	■
DOUBLE SEATED	■							
SPRING LOADED DIAPHRAGM		■	■	■		■	■	■
WEIGHT & LEVER	■				■			
CONTINUOUS SERVICE	■	■	■	■	■	■	■	■
DEAD END SERVICE		■	■	■	■	■	■	■

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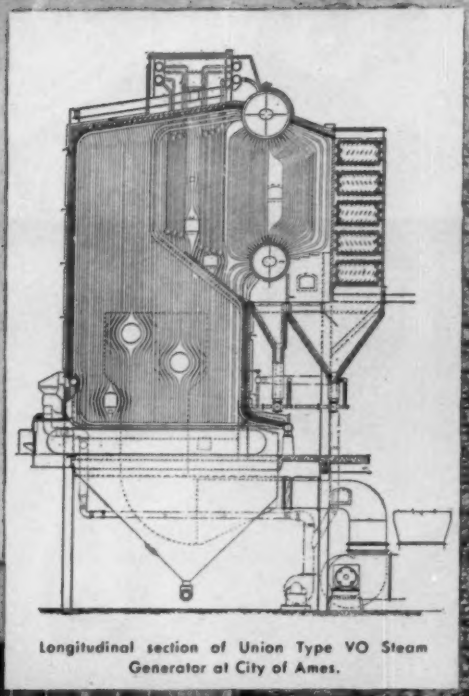

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JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

MORE INFORMATION: Many types and sizes of Union Steam Generators are described in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pennsylvania.

UNION

steam generators

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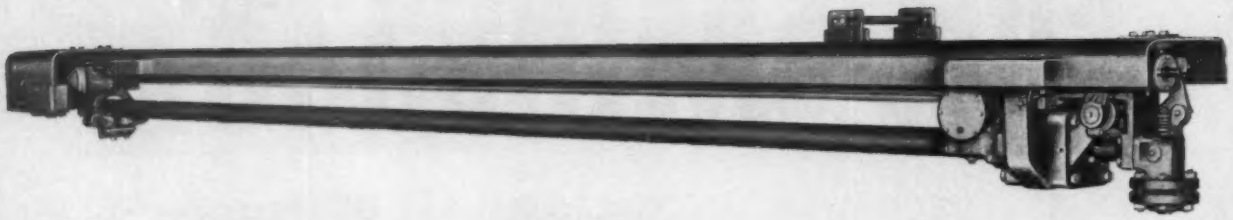

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Service tested on some 40 installations, Diamond Slurry Spraying offers a distinct economic advantage over fuel additives because it treats only that ash which collects on the tubes. Magnesium oxide-based slurry is sprayed on heating surfaces by conventional soot blowers modified to discharge, in alternate cycles, both the normal cleaning medium and slurry. The chemical slurry coating changes chemical composition of deposit so that it's easily removed by normal blowing.

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DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

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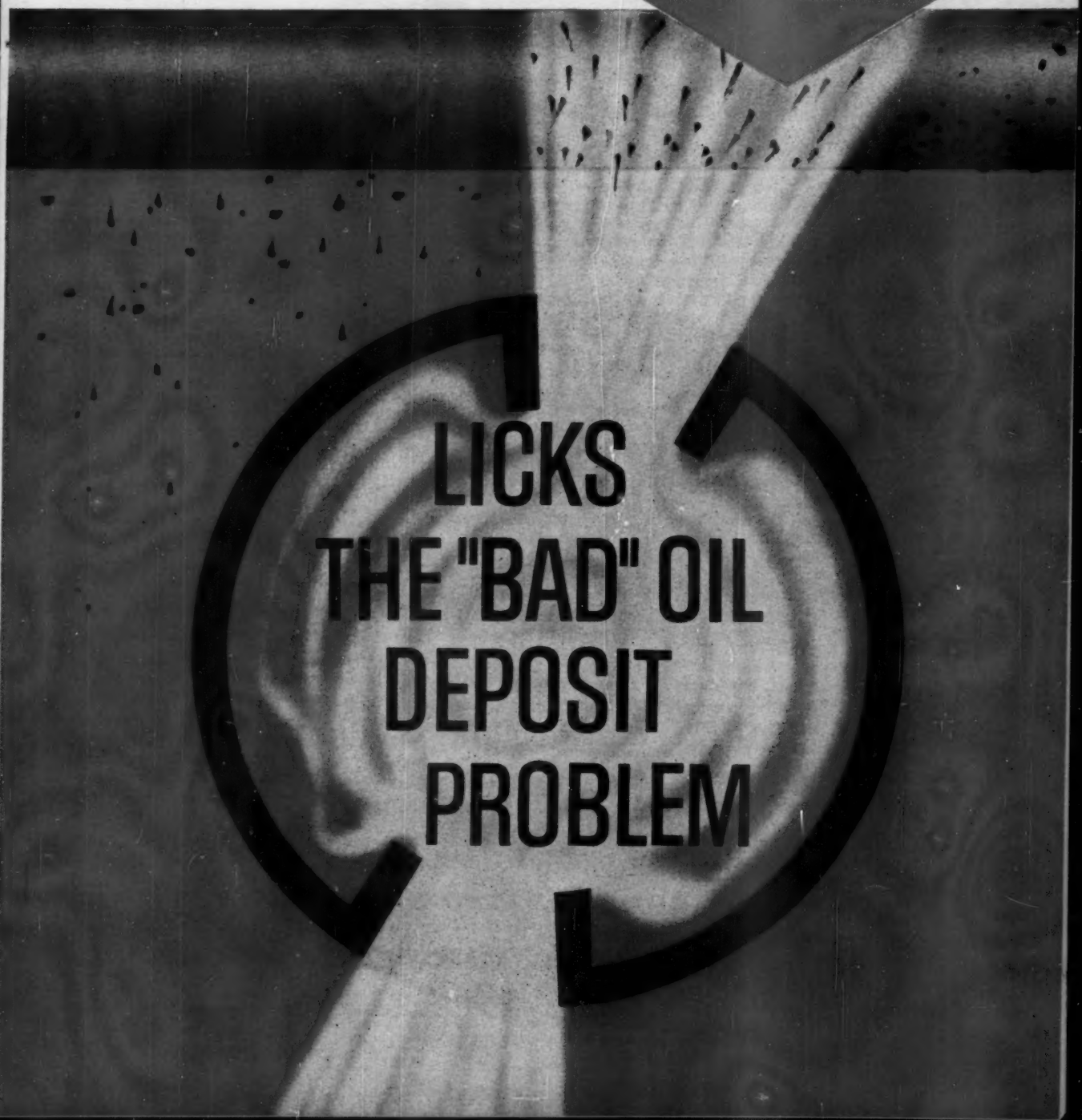
Diamond



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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER

Editor

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A brief note on some of the latest research in the controlled thermonuclear field.

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This article presents a description of the general features of the Big Rock Point Nuclear Plant of the Consumers Power Company and at the same time outlines the primary aim in the operation of this new boiling-water plant, namely, high density operation.

The Unique Experiment at Vinca 48
On October 15, 1958 a serious nuclear accident occurred at the Laboratory of the Yugoslav Federal Nuclear Energy Commission at Vinca. Six men received high doses of radiation. To accurately determine the radiation dosage received by these men, this year, under the auspices of the IAEA, an elaborate experiment was conducted at Vinca, emulating the conditions which existed at the time of the accident.

Magnetic Field Analysis in Cyclotron Design
By Paul C. Ziemke 51
At Oak Ridge National Laboratory engineers are using a novel method of plotting the structure of the magnetic field of the magnet for the new isochronous cyclotron now under construction. This article describes briefly how this method works.

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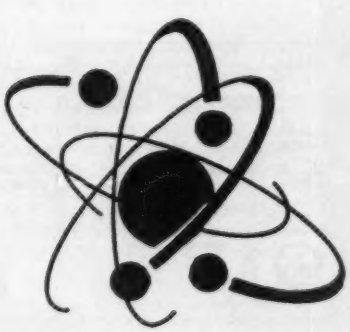


ENTROPY TRAPPING

A relatively new approach to the thermonuclear problem is being studied at General Atomic in San Diego, at Livermore, and at Los Alamos. As outlined in the current American Nuclear Society Transactions, it involves injecting a dense stream of energetic plasma from a gun into a magnetic bottle in such a way as to "inflate" it. In this "Entropy Trapping" concept the energetic stream of plasma forces its way through the neck of the bottle and by means of a disorder transition becomes trapped. The plasma particles then exhibit a pressure corresponding to random motion and are held inside by the magnetic field of the bottle. Unlike the case of the magnetic mirror, the bottle here consists of cusped magnetic lines rather like two funnels with the open ends facing each other. Various types of plasma guns are used; at Los Alamos a gun has achieved a stream of hydrogen plasma of some 5×10^{16} ions having an average energy of the order of 10 kev.

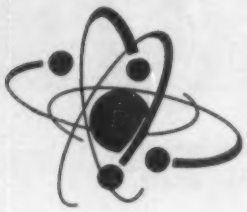
In the General Atomic experiment the plasma is observed to open the input throat of the cusp and be detained inside for about 40 microseconds with a number density of $> 10^{13}$ particles/cc. In the Los Alamos experiment, known as Entropy Trapping, the plasma is observed to force a passage through the input of the cusp under certain conditions of density and velocity and to remain in the cusp for about 40 microseconds.

One expects theoretically that if the magnetic field at the input to the cusp is made sufficiently strong its pressure should lead to the exclusion of the plasma stream. This effect has not been observed so far in the cusp experiments, although extensive experiments at Livermore have attempted its detection.

This Entropy Trapping scheme is only one of the many being tried in the continuing effort to bring about a controlled thermonuclear reaction. Research is proceeding along many fronts. The ultimate goal of the high energy injection schemes is the same as that of other controlled fusion experiments; namely the containment of the high temperature plasma at densities of about 10^{13} particles/cc for times of the order of a second or more. One difficulty is the neutral gas background. So long as the neutral gas background remains, it is quite difficult to build up high ion densities. The trapped ions, however, tend to destroy the neutral gas atoms by ionization as well as by charge exchange. There is a critical point at which the ions destroy neutral atoms as fast as they enter the plasma. Beyond this point, the neutral density drops rapidly and the ion density rises, further decreasing the neutral density. Thus, with currents only slightly in excess of the critical value, one can greatly reduce the neutral background and at the same time build up the plasma density. This process is known as Burnout.

Andrew W. Kramer

High Density Operation— Aim At Big Rock Point



Construction of Consumers Power Company's Big Rock Point nuclear power station was started early this year. The specific objective of this plant is to develop and test a nuclear core that will be less expensive and have increased power density and longer operating life than is possible with present designs. The general features and philosophy underlying the design of this plant are here described

AMONG the nuclear power stations presently under construction in the United States Big Rock Point Station of the Consumers Power Company is of interest because it is an essential link in a planned program for development of large economical boiling-water nuclear power plants. Although it is not a large plant the associated research and development program will provide technological results which can be extrapolated for application to large size plants. It is hoped that this development program will be a key factor in making nuclear power universally economical. One of the specific objectives of the Big Rock Point program is the operation of a direct-cycle boiling-water reactor at high density.

The Big Rock Point plant site is on the shore of Lake Michigan at Big Rock Point in Charlevoix County, between Charlevoix and Petosky on the northern shore of Michigan's lower peninsula. It is being built by the Bechtel Corporation as prime contractor and engineer-constructor. The General Electric Company will supply the nuclear part of the plant and the power generating equipment and will also conduct the associated research and development program on nuclear fuels. Commonwealth Associates will design certain associated facilities.

Although the initial capacity of this plant will be only 50,000 kw, its construction has created considerable interest in nuclear circles throughout the world. Considering the trend in power station design it seems that in nuclear plant construction we should be moving towards high pressure, high temperature nuclear units with capacities of 300,000 kw or more. It is toward this end that the research and development program associated with Big Rock Point will be directed. After the development program is completed, the Big Rock Point plant will become a dependable part of the Consumers system in supplying needed electric power in the northern part of Michigan.

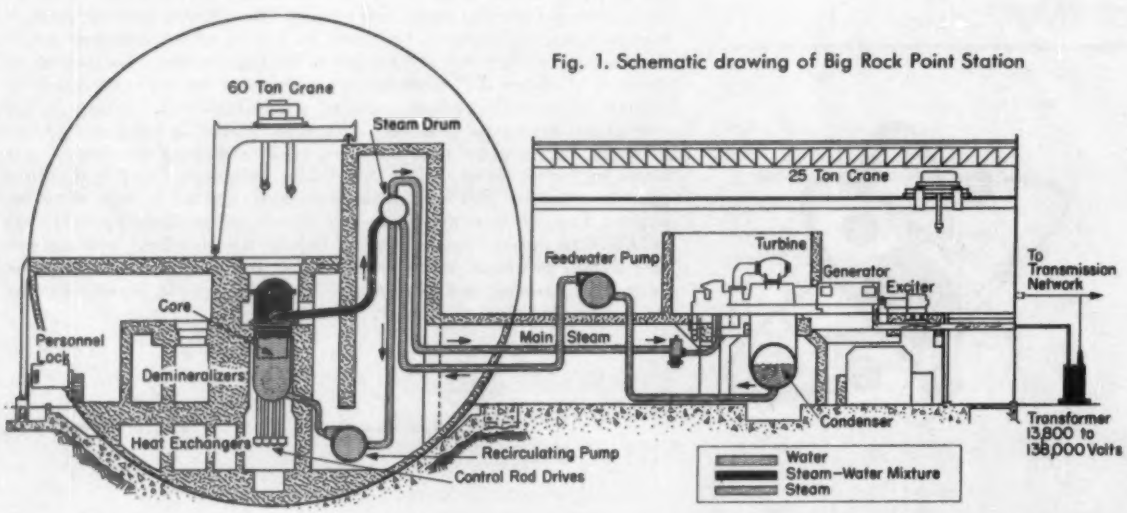
The research and development program associated with this plant will be supported by the Atomic Energy Commission, Consumers Power Company, and General Electric. It will continue through the construction period of the plant and for about 4½ years after plant start-up. The research and development activities pursued during the construction phase of the plant will be carried out at General Electric facilities in San Jose and Pleasanton, California. After start-up, the major activity will be at the Big Rock Point Plant.

The specific objective of the project is to develop and test a nuclear core which will be less expensive, have increased power density and longer life than is possible with present designs. Power density is defined as the amount of power that can be produced continuously within a given volume of core. Fuel life relates to the total amount of energy that can be obtained from a given core. Results of this program will be directly and indirectly applicable to many types of reactors.

Cost of producing electricity at the Big Rock Plant is not expected to compete with power produced in conventional plants elsewhere on the Consumers Power Company electrical system, either during the research and development program or for the immediate period following completion of the research and development program. However, it is expected that averaged over the lifetime of the plant, the cost will approach a competitive level with the conventional type plant being built today.

Under the "Fiscal Year 1960 Au-

Fig. 1. Schematic drawing of Big Rock Point Station



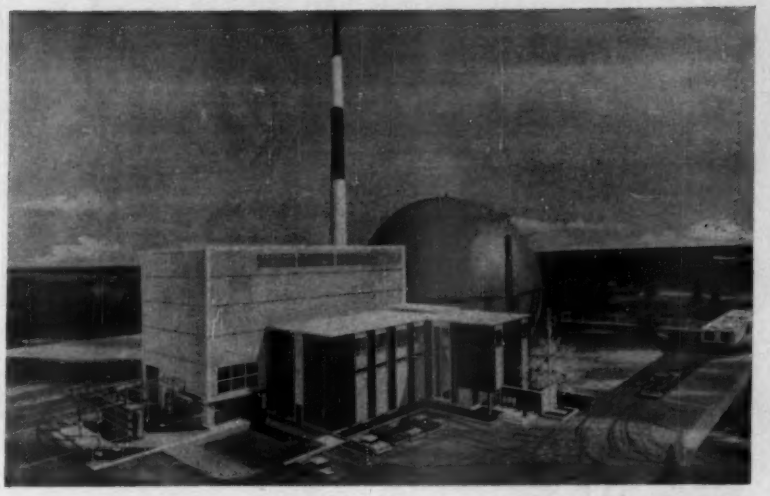


Fig. 2. Artist's conception of the completed Big Rock Point nuclear power plant after completion in the fall of 1962. The reactor and steam generator is housed in a steel sphere 130 ft in diameter

thorization Act," the AEC had authorization to construct, as part of its basic development program, a direct-cycle boiling-water nuclear power plant of the high power density type. This same authorization act made it possible for unsolicited proposals by companies or groups of companies to build and operate any of the authorized reactor projects. The Big Rock Point Plant falls in this latter category.

Consumers Power Company will be responsible for the design, construction and operation of the plant, and the General Electric Company will be responsible for conducting the research and development program. Under the contract with the AEC, the Commission will reimburse Consumers Power Company up to a maximum of $500,000 for costs incurred directly as a result of the research and development program. Fuel use charges, estimated at $1,650,000 for the first five years of plant operation, will also be waived by the AEC. Consumers Power Company will bear all costs of construction and operating the plant. The estimated total cost of the research and development program supported by the AEC and carried out by G-E is $3,700,000. It is estimated that the capital costs, including the site and site preparations, will be in excess of $27,000,000.

Construction Details

As shown in Fig. 1, the major plant structures include the reactor enclosure and the turbine building. The reactor enclosure will be a steel sphere 130 ft in diameter. The bottom of the sphere will be approximately 27 ft below finished grade. Inside the steel sphere will be reinforced concrete structures for biological shielding, equipment supports, and work platforms. The sphere will enclose the reactor, reactor equipment, and fuel storage pool. Three air locks will be provided; two for personnel access, with a larger one for passage of equipment.

A single integrated building will house the turbine-generator unit and its auxiliaries, control room, machine shop, warehouse, laboratories, offices, and other facilities.

Auxiliary equipment that may become temporarily radioactive will be housed in concrete vaults on the west side of the turbine-generator building at ground level. Other auxiliary equipment will be located on the ground floor of the turbine-generator building and at the north end of the other auxiliaries.

A machine shop and warehouse will be located on the first floor of the auxiliary section. Locker rooms will be located on the mezzanine floor over the warehouse. Offices, personnel monitoring equipment, control room, and other administrative facilities will be located on the third floor of the auxiliary section.

Reactor Design

The major components and accessories of the reactor include the reactor pressure vessel, reactor core, control rods and their drive systems, and the steam supply system.

The reactor pressure vessel is approximately 9 ft inside diameter and 32 ft inside length and consists of high strength steel alloy material clad on the inside with stainless steel.

The reactor fuel will consist of slightly enriched uranium dioxide pellets with an initial enrichment of about 3.2 per cent and encased in stainless steel tubing. A fuel assembly will consist of 140 of these individual tubes or rods, grouped for ease in handling. A total of 56 of these fuel assemblies will be placed vertically in the reactor to make up the initial core loading. The lower end of each assembly is provided with an orifice for directing the coolant water flow around each fuel rod in each assembly and also providing a means for adjusting the pattern of water flow and steam generation within the core.

Control rods will be of stainless steel containing 2 per cent boron, having a cruciform cross section and an over-all length of about 6 ft. A total of 24 control rods will be employed initially, located on approximately 10.5 in. centers, and will enter through the bottom of the pressure vessel. Each of the rods will have a drive mechanism consisting of a hydraulic piston and a mechanical latching feature that will hold the rod in any selected position. Both

Fig. 3. An aerial view of the plant site, mid-July 1960, showing the crater for the reactor containment sphere and outline of the turbine building

positioning and scram motions will be hydraulically actuated.

The nuclear steam supply system also includes a drum for separating the steam from the water, piping, and recirculation pumps. Auxiliary equipment includes a shutdown heat exchanger, and a reactor demineralizer system.

General Plant Features

The plant consists of the nuclear steam system, turbine-generator set, surface condenser, and associated auxiliary system.

The reactor is of the single-cycle, forced circulation boiling-water type. The steam generated in the core flows to the steam drum, then to the turbine, with no heat exchanger in between. The guaranteed nominal electrical capacity is to be 50,000 kw gross at a reactor system pressure of 1050 psia. Initial operation will be at a steam pressure of 1000 psi but all components will be designed to permit operation up to 1470 psi at the higher power rating of 75,000 kw.

In forced circulation operation, water is pumped into the reactor vessel by the recirculating pumps, flowing upward through the core where boiling takes place. The resulting steam-water mixture then flows upward through six 14-inch risers to the steam separation drum. After passing through mechanical steam separators in the drum, the steam then flows directly to the turbine, with the water returning to the recirculating pumps.

The plant will have an initial guaranteed gross electrical output of 50,000 kilowatts and a reactor heat output of 156,000 kilowatts thermal. With the anticipated technological developments, it is expected to achieve a gross electrical output of 75,000 kilowatts and a corresponding reactor heat generation of approximately 240,000 kilowatts thermal.

The turbine is a 3600 rpm, tandem-compound, double flow, condensing unit directly connected to a hydrogen cooled generator with a gear-driven exciter. Provisions are being made in the turbine, generator and exciter for the anticipated output based on successful results of the research and development program.

Protective Features

The reactor protection system consists of two independent fail-safe systems which must both be de-energized to result in a scram. Failure of a single component or power supply will not prevent a desired scram or cause an unwanted scram.

A tube-type tank heat exchanger system will dissipate reactor decay heat in the remote case of a scram when the main condenser is unavailable as the heat sink. This condition could be caused by a power failure or loss of cooling water for the main condenser whereupon the reactor would scram due to an increase in back pressure. As a further backup to the control rod system, a solution containing boron can be injected into the reactor pressure vessel to reduce neutron activity and insure positive control of the reactor.

Primary Targets

There are two primary targets to be met in carrying out the Big Rock Point research and development program. The first of these is to demonstrate that the plant can be operated satisfactorily at 75,000 kw gross electrical output with fuel operating at an average power density of 45 kw per liter of active core. By comparison, the Dresden Station near Chicago has an average power density of about 30 kw per liter of active core. The second target is to demonstrate that it is feasible to operate a reactor capable of supplying sufficient steam for a 300,000 kw gross electrical output plant with fuel having an average power density of 60 kw per liter of active core and permitting an average exposure of 15,000 Mw days per ton. In both phases of the program, significant cost reductions in fuel fabrication are expected. THE END

The Unique Experiment at Vinca

The reactor building at Vinca

ATOMICS

A UNIQUE scientific undertaking that is likely to make a significant contribution to our knowledge of the effects of radiation on man and to measures to ensure greater protection against such radiation was recently completed under the auspices of the International Atomic Energy Agency. For the first time in the history of the peaceful applications of atomic energy, an experiment was conducted by an international team of scientists to determine the exact levels of radiation exposure resulting from a reactor accident.

The experiment was made at Vinca, Yugoslavia, where in October 1958 six persons had been subjected to high doses of neutron and gamma radiation during a brief uncontrolled run of a zero-power reactor. One of them died but the other five were successfully treated at the Curie Hospital in Paris under the direction of Dr. Henri Jammet. In the case of four of them, the treatment involved the grafting of healthy bone marrow to counteract the effects of blood-forming tissue.

Before describing the experiment at Vinca a brief account of the accident will be of interest.[1] The reactor in which the accident occurred is an unshielded critical assembly fueled by natural uranium and moderated and cooled by heavy water. An elevation of the reactor and associated storage tank is shown in Fig. 1. Control of the reaction rate in this reactor is achieved by adjusting the level of the water moderator. The moderator level is adjusted by a pump- and-valve system. As shown in Fig. 1, the storage tank below the reactor is connected to the reactor tank by two pipes. A 2-inch gravity line provides an outlet, and a canned rotor pump and a 1-inch line provides an inlet.

[1] A detailed account of the accident was given in the *Journal* of the Boris Kidric Institute, March 1959, and in *Nucleonics*, April 1959.

The pump operates at two speeds to change the moderator level at rates of 2.5 and 0.8 cm/min. Near criticality reactivity changes at 1.5 per cent per cm. Two lowering speeds were also available: 11 and 1.7 cm/min.

Three boron-fluoride counters of different sensitivity indicate neutron flux. They are placed around the tank on the lower platform. Safety equipment consists of a supervisor's control key, two safety rods, neutron flux monitors coupled to audible alarms, and automatic shutdown circuits. The safety rods are held by electromagnets that require the presence of the supervisor's key and have separate drives. On release they fall by gravity until checked by spring-type shock absorbers in the driving mechanisms.

As reported in *Nucleonics*,[1] the lack of an interlock system and the fact that the monitors were turned off made possible the accident of October 15. An uncontrolled rise of heavy water resulted in a supercriticality that was discovered only when operating personnel smelled ozone. Figure 2 shows where personnel were standing near the tank at the time. The six men in the immediate vicinity of the bare reactor received very large doses of neutrons and ionizing radiation. Two other persons who were further away, also received radiation doses above the permissible level.

Treatment in Paris

The irradiated persons received first-aid at the Boris Kidric Institute, and were then transferred to the Centre for Professional Diseases in Belgrade. The same day Dr. Henri Jammet, Head of the Atomic Hygiene and Radiobiology Service of the Curie Foundation in Paris, was contacted. He offered to treat the six heavily irradiated patients at the centre. The patients were flown to Paris the follwing day. Of the six flown to Paris, one was cured by conventional treatment, including blood transfusions. It became clear, however, that such treatment would not be adequate for the other five patients who had been subjected to the extremely high doses of radiation. The radiation had destroyed the blood-forming tissues in their bone marrow; as a result the number of white cells in the blood fell very sharply. To provide them with new blood-forming tissue, the patients were given transfusions of bone marrow obtained from donors who were matched as closely as possible with the patients by detailed tests.

Such a method of treatment had been tried before on an experimental basis but had not proved particularly successful. One difficulty is that bone marrow injected from the outside tends to create antibodies; the patient's system refuses to incorporate the foreign substance. In this case, however, the treatment was remarkably successful. Although one patient who had presumably received the highest radiation dose died before the treatment could take effect, the four others were gradually cured. The grafted bone marrow soon began to produce new white corpuscles and the condition of the blood has now returned to nearly normal. According to one theory, the excessive radiation itself had prevented the creation of antibodies and thus facilitated the incorporation of the grafted marrow into the biological system of the patients.

A full and authentic report on the treatment of the Yugoslav patients is not yet available, but enough is known to indicate that the case represents a landmark in medical history. It has been widely suggested that bone marrow grafting may now become an invaluable method of counteracting the effects of excessive radiation exposure as a result of nuclear accidents. It may also be useful in the treatment of blood cell disorders caused by diseased bone marrow. Again, it has been suggested that the injection of bone marrow may be able to counteract certain undesirable effects of large doses of X-rays in the treatment of cancer; it follows that this would immensely increase the therapeutic value of x-rays.

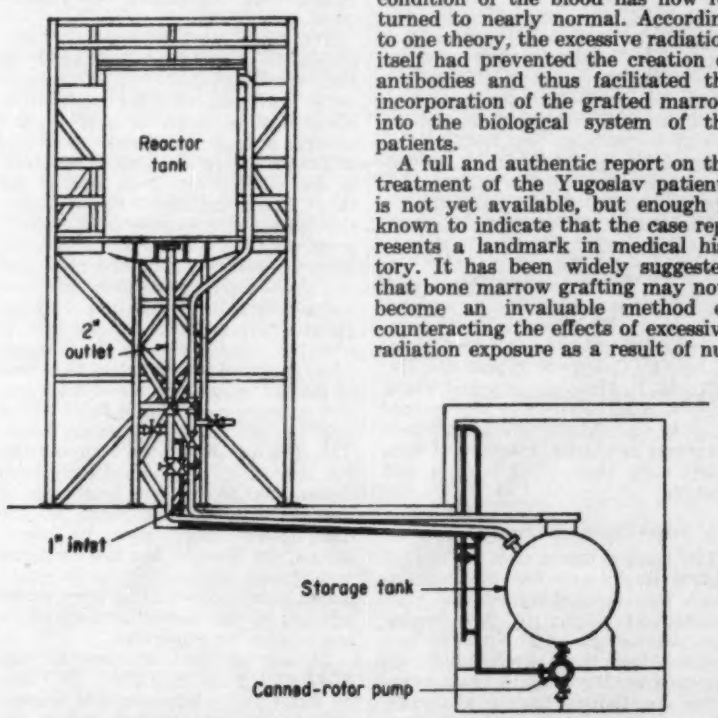


Fig. 1. Section showing the reactor tank on supporting platform and storage tank below. The canned-rotor pump fills the tank; gravity flow empties it

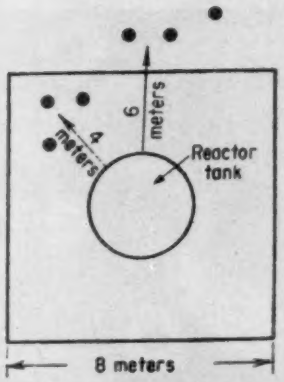


Fig. 2. The heavy dots in this diagram indicate the position of the men who were exposed to the radiation at the time of the accident. Two others much farther away received doses greater than permissible

Radiation Doses

It is certain that the success of the treatment of the Yugoslav patients will intensify further research in this field, but the value of the experience gained would be greatly increased if the extent of their radiation exposure were precisely known. If the exact doses can be ascertained, it will be possible to correlate them with the effects observed in the patients in the course of their treatment. And such correlation, apart from its value in general radiobiological investigations, would help further development of the method of treatment of radiation injury as adopted at the Curie Hospital.

According to a report published by the Boris Kidric Institute, it was estimated the irradiated persons received a total average whole-body dose of 683 rems of neutron and gamma radiation. The rem is the unit of ionizing radiation which has approximately the same biological effect as one roentgen of x-rays. Since a dose of 400–500 roentgens is considered to be lethal in 50 per cent of cases, the doses received by the Yugoslav patients would indicate that the outcome would have been lethal but for the revolutionary treatment given at the Curie Hospital.

Although this conclusion remains valid, further scientific research must be based on more precise data on the radiation doses. Here then was a unique opportunity. If the doses could be established more precisely, it would be possible to correlate

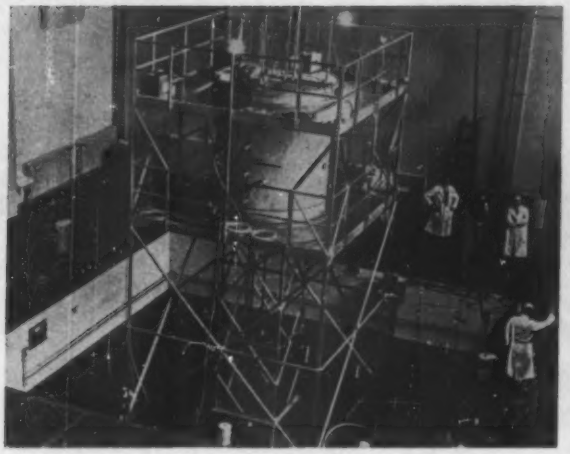


Fig. 3. General view of the critical assembly at Vinca with one phantom at the right-hand corner

Fig. 4. View in the reactor room at Vinca showing the phantoms in position ready for the experiment

them not only with the effects of the radiation exposure but also with the effects of the treatment given.

The Experiment at Vinca

It was the object of carrying out such radiation dose tests that the International Atomic Energy Agency at Vienna decided to conduct the experiment at Vinca. The Director General of the Agency suggested to the Yugoslav authorities that a dosimetry experiment by an international team of scientists be conducted at Vinca. The Yugoslav authorities agreed to the suggestion and assured the Agency of their active coöperation in the project. A formal agreement was concluded between the IAEA and the Federal Nuclear Energy Commission of Yugoslavia on February 2, 1960 under which the IAEA assumed the responsibility for organizing and carrying out the experiment by re-starting and operating the reactor with adequate measures of safety and special arrangements for radiation measurements.

The Agency held extensive consultations with the atomic energy authorities of different countries, and numerous countries and groups indicated their willingness to assist in the execution of the project. It was, however, found necessary to limit the actual participation to as few groups as possible. Yugoslavia agreed to place the reactor and the laboratory premises at the Boris Kidric Institute at Vinca at the disposal of the Agency and to provide consultants, personnel, instruments, and services.

For the special purposes of this experiment it was arranged that experts from the French atomic energy center at Saclay would redesign the control equipment of the reactor and be responsible for its start-up and operation. The heavy water (6.5 tons, worth approximately $400,000) needed as moderator for the reactor was offered free of charge by the United Kingdom Atomic Energy Authority. Health physics experts of the Oak Ridge National Laboratory, USA, who have specialized in this kind of experiment, offered to undertake the radiation measurements and provide the necessary equipment for the purpose. A British scientist joined the American team with some equipment for radiation measurements. The Boris Kidric Institute at Vinca made many basic preparations on the reactor and the reactor premises and added the necessary shielding to the walls of the reactor room to enable the reactor to work at much higher power than originally designed for. A higher power level was chosen for the experiment to facilitate the measurements. The Institute made consultants and technicians available for the experiment and provided a great deal of administrative support as well as extensive facilities in matters of organization and physical arrangements, essential for the smooth and efficient conduct of the experiment.

The heavy water from Harwell arrived at Vinca at the end of March. Twelve French experts, led by Dr. Jacky Weill and Jacques Furet, and the equipment from Saclay arrived at the beginning of April. The American team of seven health physicists, led by Dr. George S. Hurst and Dr. Rufus H. Ritchie, also reached Vinca early in April with their highly specialized equipment, including four phantoms or plastic dummies of men which were then filled with a salt solution.

Start-up and Operation

The control board and the related control equipment for the reactor, which had been designed and constructed at Saclay in five weeks' time, was assembled at Vinca in two weeks. After these preliminary arrangements, the French team completed the tedious task of siphoning 6.5 tons of heavy water from the barrels into the reactor system in less than a day. The reactor, which had not been operated since the accident on October 15, 1958, went critical again for the first time at 18:09 hours on April 20. The critical level of the water in the reactor as well as the operation and efficiency of the control rods and the remote control equipment were checked. Good results were achieved and it was possible to operate the reactor the same evening at a power level of 5 watts during eight short periods for the dosimetry experiment. On April 22 it was operated at a power level of 1 kilowatt and on April 25 it was brought to a power level of 5 kilowatts, thus concluding the experiment.

The most accurate modern techniques of dosimetry developed at the Oak Ridge National Laboratory were used during the experiment. Simultaneous measurements of the neutron and gamma doses were made at points where the people involved in the incident had been located. At these points the effects of the radiation on the salt solution in the phantoms were studied. In particular, the energy distribution of the radiation was investigated, because the biological effects of the neutrons and the gamma rays are different. In fact, it was the ratio between the various components of the radiation that was of special interest in these measurements because this ratio itself would help in determining the exact doses. The dose of one of the components, *viz.* slow neutrons, had already been determined during the treatment of the patients. If the ratio of the components could now be ascertained, the doses of the fast neutrons and gamma rays could also be established because the ratio would not be affected by the power level at which the reactor was operated.

Details of the experiment were given at a press conference at Vinca on April 27 by the scientists responsible for its organization and execution. Dr. Henri Jammet was also present. G. W. C. Tait, Director of

IAEA's Division of Health and Safety, opened the conference with a general account of the experiment. Describing some of its unique features he said: "It has demonstrated international solidarity in an extremely delicate field in which this work is a pioneering step. It promises to be of very real benefit to science and the results will be made known to all countries which are members of the IAEA and the United Nations."

Describing the modifications carried out on the reactor by the French team, Dr. Weill said that before the experiment the reactor was not designed to be operated at the power level necessary for the dosimetry work to be undertaken. Two things were important for the experiment: to increase the safety of operation and to install the necessary control mechanism to operate the reactor at power levels many times higher than those for which it had been designed. A correspondent asked whether the conditions under which the experiment had been made were exactly similar to those at the time of the accident of October 1958. Dr. Hurst explained that it was not necessary to reconstruct the exact conditions of the accident because the techniques of dosimetry did not depend on this. Besides, it probably would have been impossible to reconstruct the exact situation because of certain unknown factors, particularly those associated with the exact location of the affected persons at the time of the accident. Dr. Weill said that what was interesting was to determine the nature or composition of the radiation, i.e., the relationship between the neutrons and the gamma rays. Mr. Tait added that the experiment was designed to obtain specific scientific data and even if it had been possible to reproduce the physical conditions of the accident, he doubted whether it would have been desirable to do so. At the same time, it was pointed out that it was important to keep the configuration of the reactor exactly the same as it was during the accident because scattering on the walls, floors, and objects in the room influences the distribution of thermal neutrons and this might alter the relationship of the dose already determined during the treatment of the patients. THE END

Magnetic Field Analysis in Cyclotron Design

By PAUL C. ZIEMKE

THE LATEST addition to the scientific equipment at the Oak Ridge National Laboratory is the Isochronous (ORIC) Cyclotron, now under construction. The engineers engaged in the design and construction of this machine have been using a magnetic field plotting system that represents a great advance over previously used methods both as regards speed and accuracy. By its use it is possible to completely evaluate the detailed performance of the machine before it is actually built. The ORNL Electronic Research Division has been using this new field plotting system in measuring the strength of magnetic fields of complex configuration in greatly reduced time, and with exceptional accuracy.

The new, well-coördinated mechanical-electronic system automatically programs and positions a small sensitive element that provides a voltage signal directly proportional to the strength of the magnetic field under scrutiny. The small size of the sensitive element, which utilizes the Hall Effect, contributes significantly to the extremely accurate measurements possible with this system. The effectiveness of the probe, a thin wafer of semi-conducting material only $\frac{1}{32}$ in. in area, is greatly enhanced through the use of a newly developed compensating network which minimizes the effect of temperature variations during the period of measurement.

The Hall Effect is not new. It has been known for many years, in fact, it owes its name to its discoverer who in 1879 found that when a transverse magnetic field is applied to a conductor carrying current, a transverse voltage is produced across the conductor. The Hall principle is shown in the accompanying diagram. Here a thin section of semiconductor material is placed at right angles to a magnetic field. A control current I_c is passed through the semiconductor as shown. Under these conditions another voltage (the Hall voltage) is generated across the semiconductor at right angles to the control current. The Hall voltage is proportional to the product of the control current I_c and the magnetic flux density B. Such an element, therefore, can be adapted to the measurement of magnetic fields and this is done in the system developed at Oak Ridge.

A quarter-scale model magnet using up to a maximum of 400 kw of electric power is now under test, using this method of plotting. The several earlier cyclotrons at ORNL, built largely from salvage materials rescued from the discontinued electromagnetic separation process, once a major producer of U^{235}, were designed to accelerate only one type of atomic particle to a relatively low energy level. This machine employed a very uniform (flat) field that tapered off but slightly toward the edges of the magnet to offer some degree of focusing.

Now, however, to achieve the higher energies desired in the new cyclotron the average field strength must increase towards the edge of the magnet to compensate for the relativistic increase in mass [1] of the ions at higher energies. To produce the desired strong focusing forces a three-fold magnetic lens system is to be built into the magnet for the new cyclotron.

An earlier way of evaluating and correcting the magnetic field of cyclotron magnets was to choose the best known magnet design and then, by actual operation of the completed cyclotron, trace the paths of ions outward from the center. When such ions got lost the magnet was doctored or tailored by patching or

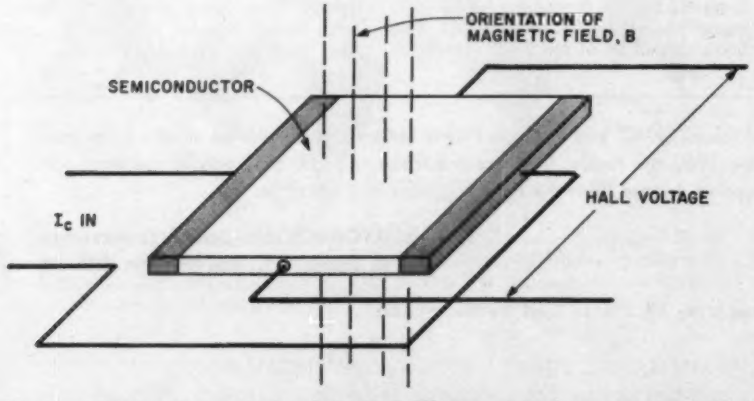


Diagram showing the principle of the Hall Effect used in the magnetic plotting method at Oak Ridge National Laboratory

[1] One of the predictions of the Einstein theory is that the mass of a particle increases as its speed approaches that of light. At ordinary speeds the effect is negligible but at the speeds of particles in modern high energy accelerators it becomes significant and provision must be made to allow for this increase in mass.

ATOMICS

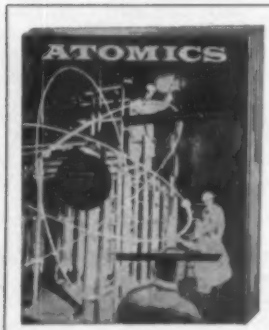
grinding as was required until an acceptable performance was achieved. Admittedly, this was a slow, expensive, and unscientific process even for machines with uniform fields. For a complex field configuration such as in the ORIC it would be virtually endless and impractical.

Although the recently developed methods of flux measurement and orbit determination simplified the problem of cyclotron design, the vast number of measurements required for high flux fields necessitated greater speed in calculating the course of the ion paths. For uniform magnetic fields it is comparatively simple to calculate the path every type of ion will follow but for the complex type fields in the new cyclotrons the paths can be determined only by means of high-speed computers. At Oak Ridge National Laboratory, with the new accurate measurement technique and the methods developed for data processing by means of fast computers, it is possible to produce an evaluation in an average time of around 36 hours.

With this precise field measurement techniques and computer codes the Oak Ridge engineers may, in effect, test a host of designs in cyclotron development well before the accelerator is erected. The new techniques make it possible to conduct a search for standards and specifications for cyclotron operation unattainable under the earlier handicaps.

New Nuclear Literature

A United States Government report that is of considerable general interest published recently is one entitled, *Potential Nonnuclear Uses For Depleted Uranium*. This report, TID-8203, also is available from the Office of Technical Services, Department of Commerce, Washington, D. C. at $0.75. To acquaint the public with some of the properties and some of the nonnuclear uses that have been suggested for depleted uranium, the AEC requested Battelle Memorial Institute to survey the pertinent information available. For the purpose of this study, it was assumed that anywhere from 10,000 to 20,000 tons of depleted uranium could be made available annually for industrial applications outside the nuclear field. As pointed out in this report, the study showed that substantial opportunities for the profitable use of this interesting material by private industry probably exist. The report describes the physical and chemical properties of depleted uranium and its principal compounds and suggests many possible uses. For example, it has application in the ceramic industry as glazes, and refractories. In the electrical field it has application as a semiconductor. Metallurgical applications, radiation shielding and ceramic uses are presented in some detail. The first two would appear to offer potential applications which could lead to markets involving substantial tonnage. It is pointed out that only a few of the uses for depleted uranium would find increased markets in the immediate future solely on the basis of lower price at the point of delivery. These are for markets that have already been developed or studied, such as ceramic uses and applications in radiation shielding. Most of the potential uses will require research and development and trial on an industrial level before significant markets can be developed. To do this will require a period of time and few new markets could logically be expected to develop within the next 5 years. * * * The advent of nuclear energy is usually regarded as a development that belongs solely to the realm of physics, yet much of the work involved in bringing the art to its present stage of importance in the world is due to chemistry. The great diffusion plants at Oak Ridge and elsewhere operate by virtue of both chemical and physical processes and the large separation plant in Idaho are chemical plants. To portray the role of the chemist and chemistry in the nuclear industry, the philosophical Library has recently published a book entitled *Chemistry of Nuclear Power*. This book (208 pages, 6 by 8½ in., cloth) is authored by J. K. Dawson and G. Long, both of Harwell, the Atomic Research Establishment in England. It gives a highly informative account of the vital part played by chemists in the over-all program of the development of nuclear power. No attempt, however, is made to give a minutely detailed account; the reader is referred to the list of key references at the end of each chapter if he wishes to develop a more intimate knowledge of this field. The book should be of use and interest to those who have had some scientific training and who wish to become more closely acquainted with the impact of atomic power development upon almost all of the elements in the Periodic Table. *Chemistry of Nuclear Power* is published by the Philosophical Library, Inc, 15 East 40th Street, New York 16, N. Y. Price $10.00. * * * *Electronic Processes in Solids*, by Pierre R. Aigrain, Roland J. Coelho, and Gianni Ascarelli, is a new book published by John Wiley & Sons, Inc, and the Massachusetts Institute of Technology Press. This is a small book (64 pages, 6 by 9 in. cloth) based on a series of lectures given by Dr. Aigrain during the spring of 1957, while he was visiting Webster Professor of Electrical Engineering at MIT. It was prepared by Drs. Coelho and Ascarelli from notes taken at these lectures. This is decidedly not a book for beginners. It is intended for those with a good background in calculus and wave mechanics. It presents a detailed analysis of band theory and transport theory in covalent semiconductors on a level intermediate between that of the original work and that of elementary treatments. The major assumptions are discussed in some detail but the mathematical developments are only indicated. The rather new thermodynamic approach to transport theory and a unique treatment of the "hot electron" problems will interest nuclear physicists concerned with solid state theory. This book is available from John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. at $4.



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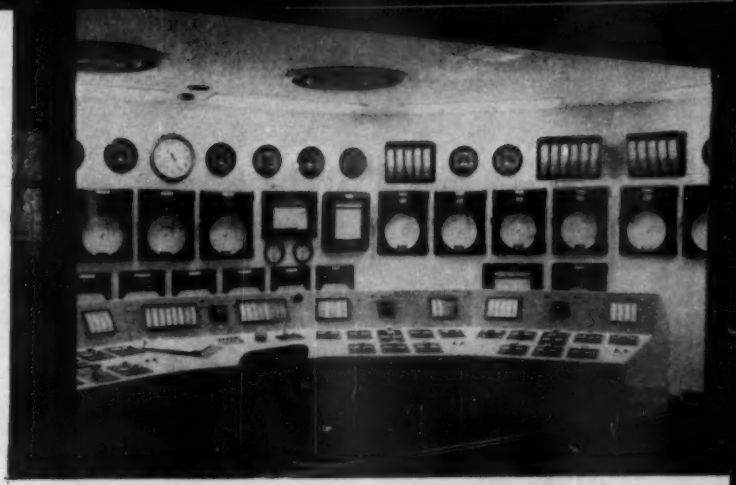

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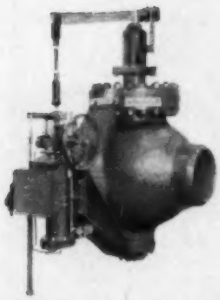

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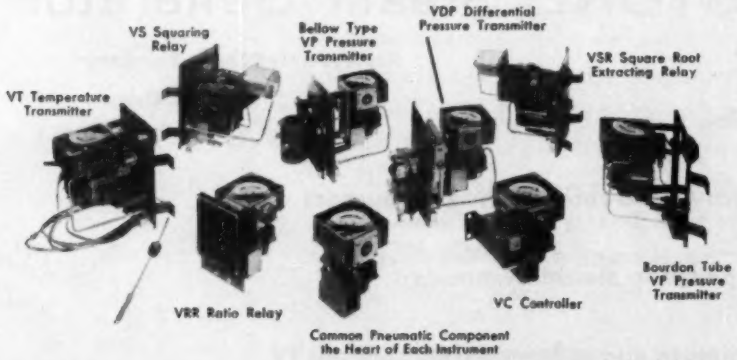
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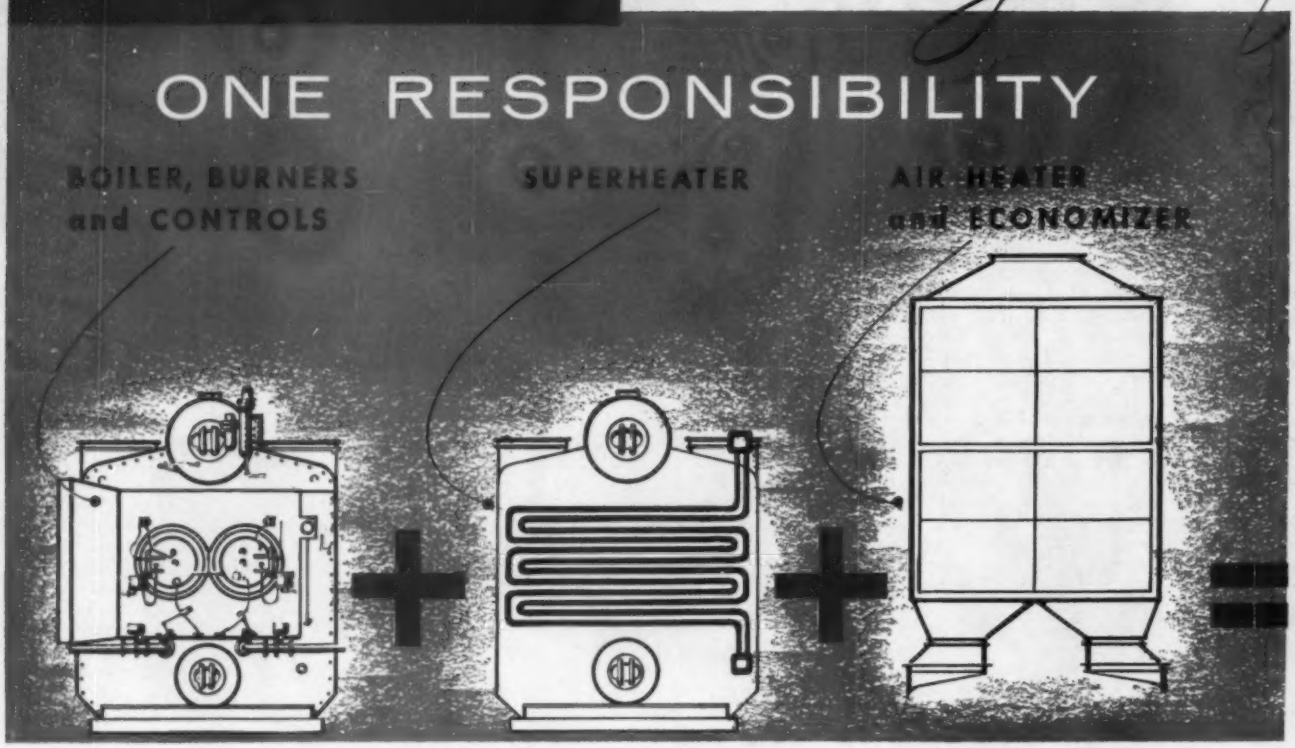

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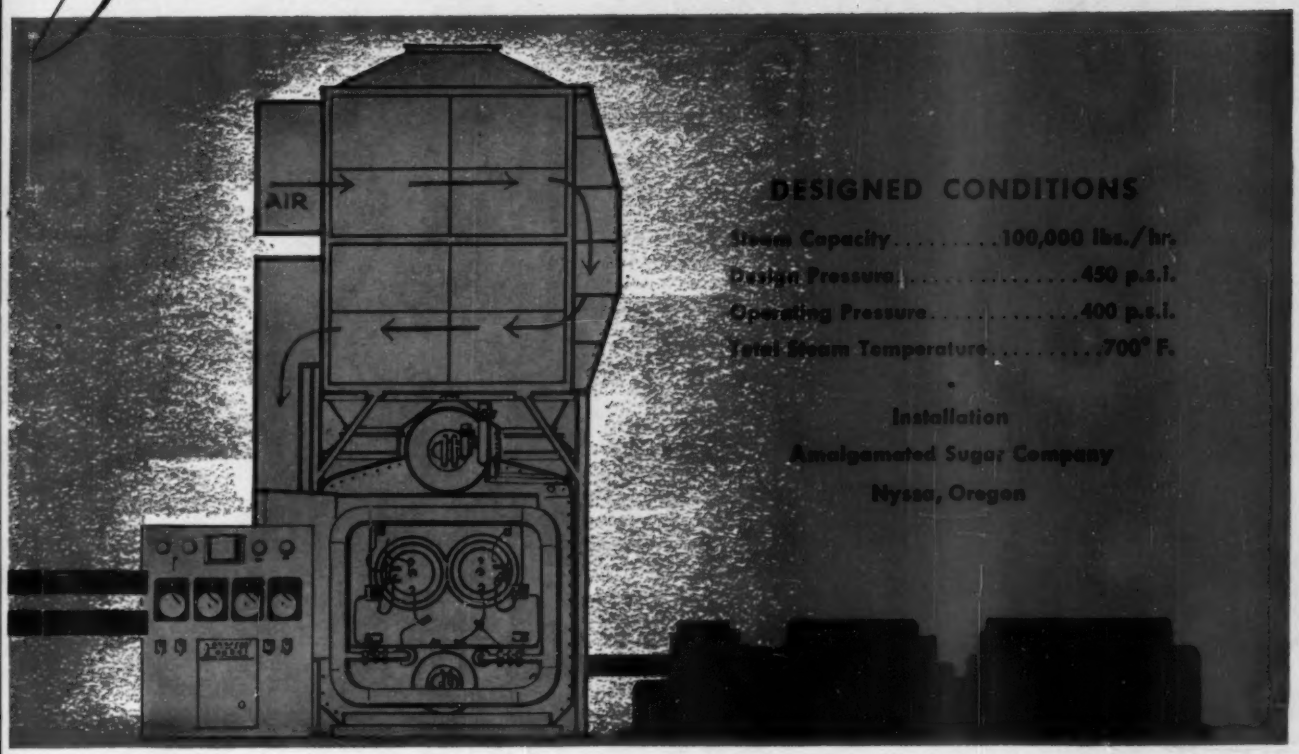

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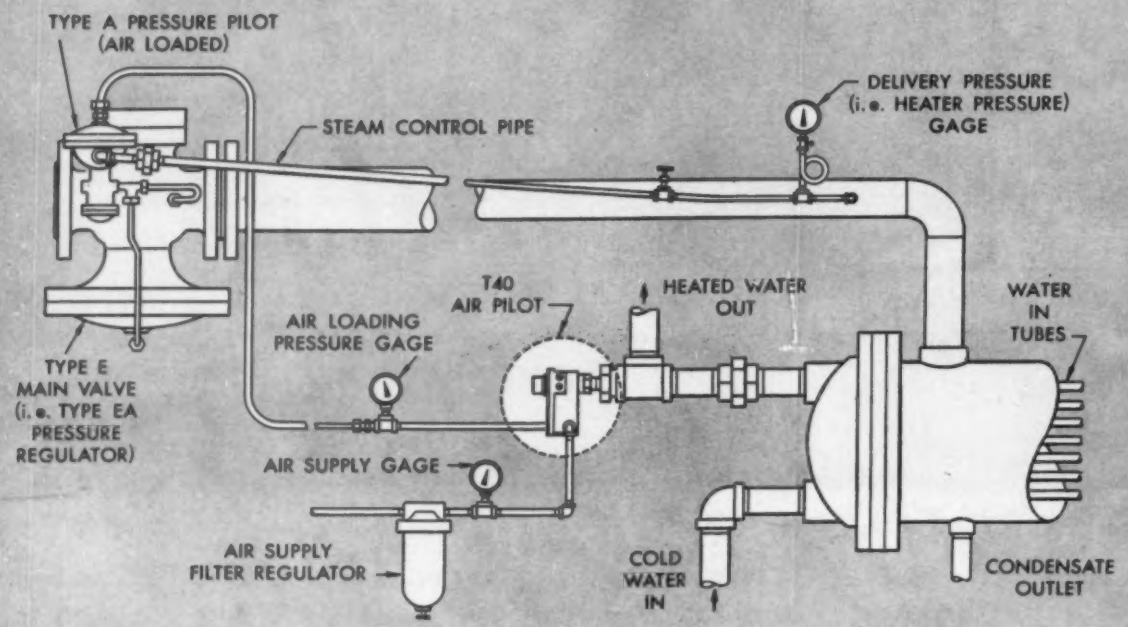
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Following our policy of keeping POWER ENGINEERING's readers currently informed on important subjects, a special section on Peaking Power claims a major portion of this issue. Read what some of the country's top experts have to say on this timely subject, beginning on page 59.

ANNOUNCEMENT

Arthur L. Rice, Jr, 45, has been elected president of Technical Publishing Co, succeeding his brother Kingsley L. Rice, who died recently. Long a key figure in the management of the magazines POWER ENGINEERING and PLANT ENGINEERING, Arthur Rice joined Technical Publishing Co in 1945. He became treasurer in 1947 and executive vice-president a few months ago. He is the son of Arthur L. Rice who in 1908 was one of the founders of the company and who for many years served as editor and publisher.

Arthur Rice, Jr, is a graduate of the University of Illinois, with a B.S. in Industrial Administration. Prior to entering Technical Publishing Co he worked with Procter & Gamble in Cincinnati.

Y news briefs

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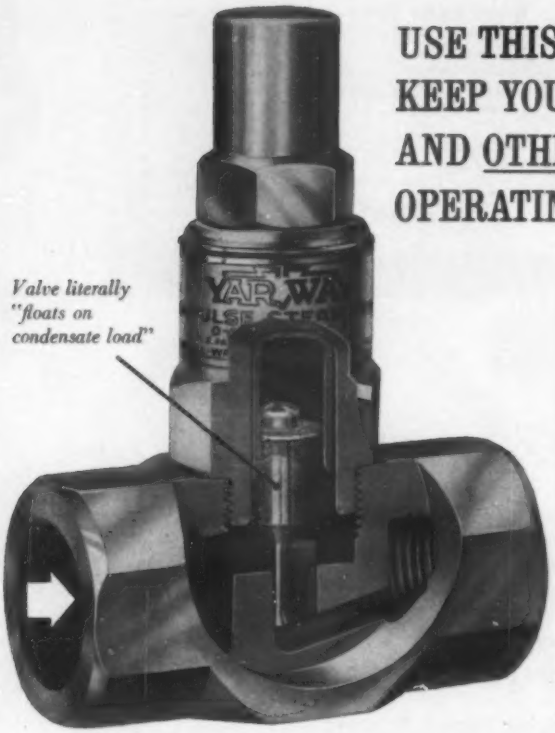

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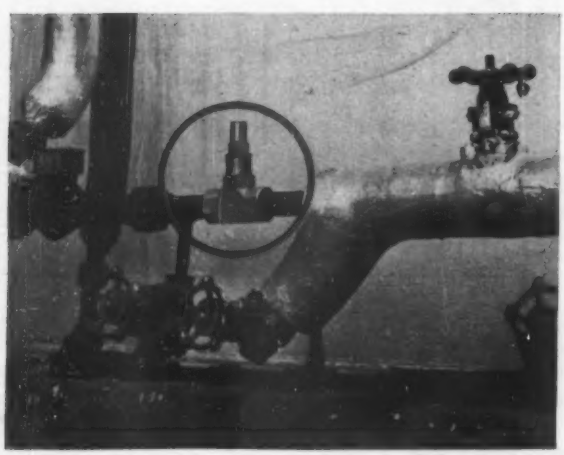

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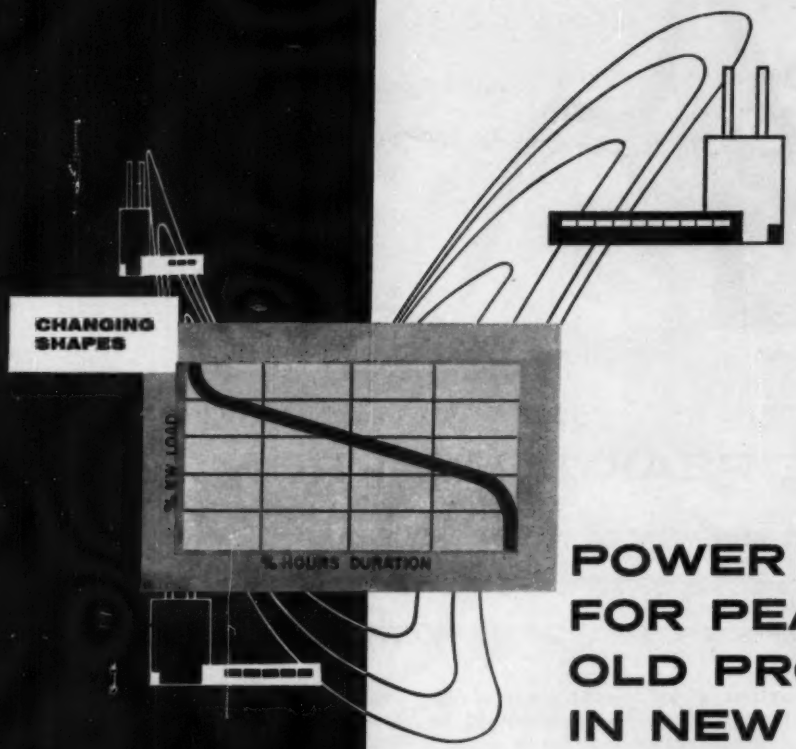


POWER ENGINEERING FOR PEAK LOADS— OLD PROBLEM IN NEW GUISE

Interconnections

Power Pools

Steam Turbines

Diesels

Gas Turbines

Hydro Plants

Pumped Storage

What It Costs

TODAY THE MIGHTY power industry of the United States, marvel of the world, is filled with changing shapes. Discussions of an important one — power for peaking — appear on the following pages.

It must be emphasized that these discussions apply to the conditions that prevail right now. There is always the possibility that those conditions may not be the same two or three years from now. They will certainly not be the same 20 years from now.

For example, we do not know what effects the developments in high-voltage transmission, nuclear power and other non-conventional sources of power may have on our power system operations. Complete automation and operation of entire power systems by computers — which is coming fast — may tell us things about those systems we never knew before.

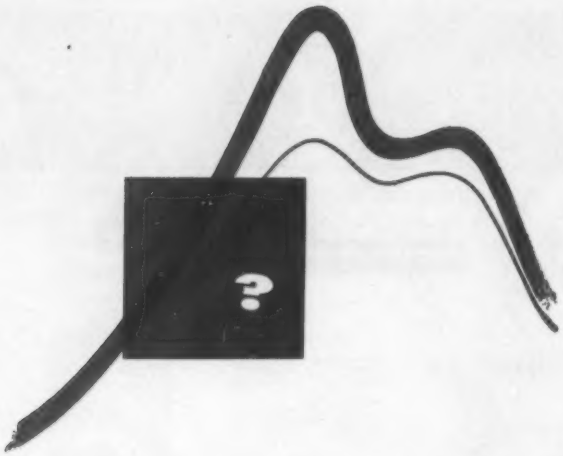
Principal reason for the present concern with peak load power lies in consideration of costs. As systems and units grow in size, their cost per kilowatt may decrease, but the total capital expenditure for them grows large. Fixed charges on that capital expenditure form a very sizable part of power costs. Those fixed charges must be kept as low as possible, to keep cost per kilowatt-hour down.

New methods of building and operating steam-turbine generating units for this purpose are described. Value of using interconnections to obtain peaking power is emphasized. Very important are the present and projected uses of internal combustion engines and gas turbines for peaking, supplementing conventional steam units. New interest has arisen in pumped storage projects for peaking.

There may be differences in power systems demanding different approaches to peaking. But always the objective is the same — reliability of service and lowest cost to the user of electricity. For underlying all is the mighty power engineering industry.

To keep you abreast of the constantly-changing shapes in the ever-dynamic field of POWER ENGINEERING, we present the second of a series on CHANGING SHAPES IN THE WORLD OF POWER

EDITED BY Chester R. Earle SPECIAL PROJECTS EDITOR



WHAT IS THE PEAK LOAD PROBLEM?

FACTORS AND METHODS TO BE CONSIDERED IN MINIMIZING COSTS OF SUPPLYING THE PEAK LOADS,

REVIEWED BY CHESTER R. EARLE, SPECIAL PROJECTS EDITOR

BRIEFLY, the problem is this: In recent years, as utility power generating unit sizes and efficiencies have increased, most of the units now available to handle power system peak loads are **too good** for them. Formerly they were only **good enough.**

In the past, power utilities could not afford to overlook the advantages of large fuel and other savings offered by the rapid improvement in new steam units. They added these high-efficiency units first on base load. Then, as newer and even more efficient units were added to the system, these in turn were put on base load, relegating the older, less efficient units to lower load-factor operation, and finally to peaking service.

But each advance in the steam cycle has resulted in smaller gains, Fig. 1; and each step has been more expensive and difficult. Moreover, new types of generating equipment have recently become available — to offer the possibility of lowering installed-cost-per-kilowatt. Consequently, many utilities are now considering ways of installing combinations of several types of equipment to achieve greater system economy, instead of sticking to the traditional expansion pattern.

What Is Peak-Shaving?

What do we mean by "peak load," "peak-shaving," "peaking?" The peak load on a power system or generating unit is that portion of its output needed to supply a relatively large part of the load, say 10 to even 20 per cent of it, for a very short time, say from 1 or 2 per cent up to about 10 per cent of the time. The rest of the load, called the base load, is carried by various combinations of expensive, highly efficient units. So the terms peak-shaving and peaking refer to the methods used to find a less expensive way to "shave" the peaks economically, and make the load curve of each efficient unit as near maximum efficiency as possible. This obtains reasonable return on the large capital investment required for them.

Of course, that is modified in practice, for we must always have capacity available to meet sudden unforeseeable load surges. We may have it as system reserve capacity, sometimes as "spinning reserve." As a result, while cost per kilowatt of newer units has not increased unduly, much larger capital investment is required for the larger units, hence higher fixed charges, a major item in costs besides fuel cost.

A load duration curve like Fig. 2 can be misleading, because the few peak load hours are actually scattered over a large part of the year. On a typical Northern system, the top 12 per cent of the peak load occurred only 126 hours or 1.5 per cent of the year, but was distributed over 41 different days in 7 different months. Peak generation capacity must actually be ready and available over a larger period of time. Seasonal peaks, such as those caused in the Southern states by air conditioning load, must also be taken into account.

Power system analysis must take into account such items as: fixed-charges on present and projected generating equipment; costs of fuel; over-all system heat rate; effects of inflation on capital costs; maintenance costs; transmission line costs, if any, for peaking units; deferred investment savings; interest during construction; operating labor cost; start-up and spinning reserve cost; transmission effect of peak-shavers; fuel penalty on peaking due to over-all system heat rate increase (may be as much as $40 per kw); effect of time zones.

Steam Units for Peaking

Much general utility feeling is that the steam-electric generating unit, with suitable modifications, is the best unit for many cases. It is possible to work out steam-turbine units to operate efficiently on base load and still have additional built-in capability to handle the peaks. This requires care in design of boilers and all the auxiliary equipment to enable them to take the overload. This overload capacity may be already built into equipment. New generating units can be designed as spinning reserve or extended capability units, operating at high efficiency and low cost per kilowatt-hour on the base load but capable of as much as 20 to 40 per cent additional output for peaking.

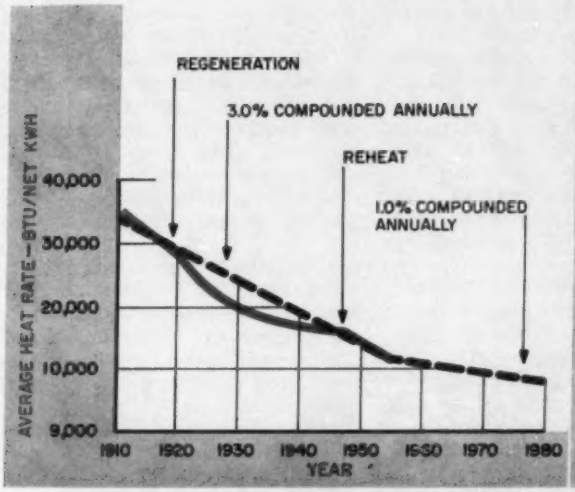


Fig. 1. Average net heat rate of new installations (Ritchings and Bennett, 1960 APC) based on EEI and manufacturers' data

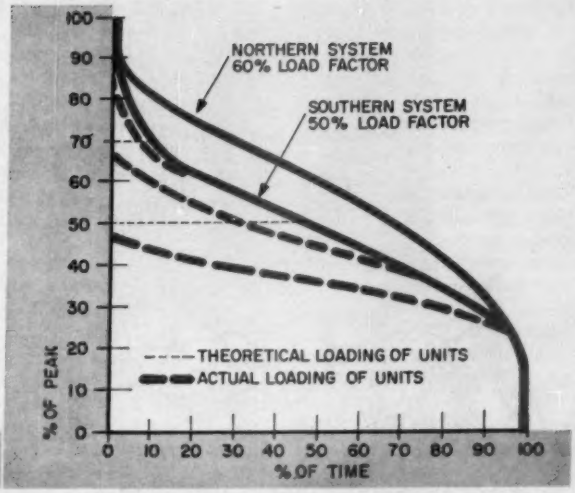


Fig. 2. Annual load duration curves (LeVesconte and Kolflat, 1960 APC) for typical Northern and Southern power systems

One Midwestern utility has just ordered a unit of this type. It has a name-plate rating of 125 Mw, steam conditions 1450 psi, 1000/1000 F, but normally will operate at about 150 Mw. However, it can supply peak load power up to 175 Mw, at sacrifice of efficiency, by cutting out the two top feedwater heaters, raising the steam pressure 10 per cent, and decreasing the initial steam temperature to 950 F (but retaining the reheat). The 1,000,000-lb-per-hr coal-burning boiler has been designed with enough pulverizer capacity and other auxiliaries to supply up to 1,250,000 lb per hr for peaking operation.

It is always assumed that the first thing to do is to analyze the system and consider how peak loads can be met by interchange of power through interconnections with other systems. This will be discussed in another article.

Special Equipment

During the next 20 or 30 years, developments in some of the "exotic" sources of electric power may affect the design of electric systems. Such new sources as MHD, fuel cells, thermionic and thermoelectric devices and, of course, nuclear power, may make it feasible to install new types of generating plants at many points on a system, instead of having a few large plants and transmitting their power long distances.

Already, recent developments in diesel engine units and gas turbines, which can be installed for about $110 per kw, as compared with $140 or $150 for efficient steam plants, are of much interest. Several private utilities and some municipal systems are installing them — automatic, remote-controlled and unattended, for peaking service, as detailed hereafter.

Hydro and Pumped Storage

Pumped-storage plants for peaking have been used in Europe for many years, but our abundance of fuel and of conventional hydro plant sites and our other conventional developments have not encouraged them here. Until a few years ago, only 4 U. S. pumped-storage plants were in operation. But now many others are under construction or planned — Sir Adam Beck, Tuscarora (Niagara), Smith Mountain, Taum Sauk, and others. A proposed Feather River development in California would contain several pumped-storage units.

Concerning the Taum Sauk 350-Mw pumped-storage project of Union Electric Co, a detailed discussion of the way it was approached, analyzed and finally designed, will be published in the next issue of POWER ENGINEERING. Offering many benefits, it is one of the first true pumped-storage projects, used solely for peaking.

Conventional hydro plants are used, of course, both as base load plants and as peaking plants. The method depends on system conditions and the combination of hydro and thermal plants employed.

All the foregoing points are amplified in the articles following in this section. Several case studies are given by top power engineers. THE END

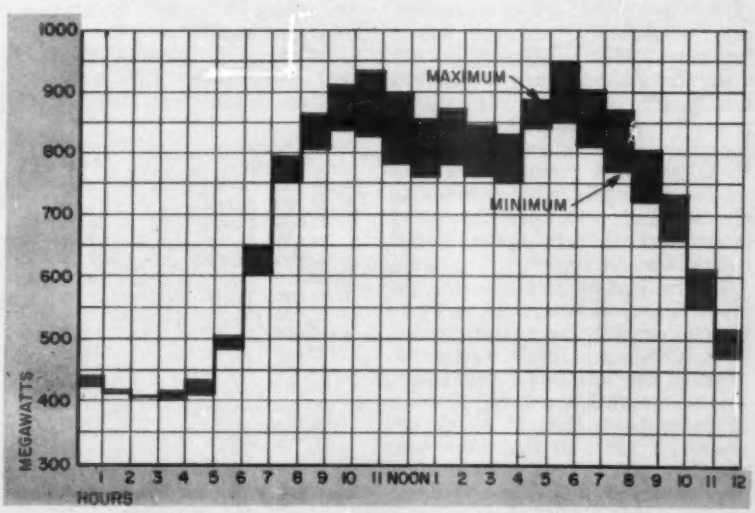


Fig. 3. Hourly loads of week days like this must be studied in connection with load duration curves

Fig. 1. This EEI diagram of principal interconnected electric transmission lines in U.S. shows how the power systems are integrated

LOOK FIRST AT INTERCONNECTIONS

THOROUGHLY discussed at present by power utility engineers, their consultants, and the manufacturers of their equipment, are the many factors previously mentioned that have to considered in supplying power for peak loads under today's conditions. But in every such analysis, the first factor to be considered is the possibility of obtaining the required peak load power by interchange through system interconnections.

In the United States today, the power utility industry has well over 300,000 circuit miles of transmission lines operating at 22 kv and above. Making the inevitable comparison, Russia reported about 46,000 miles of transmission lines at 35 kv and above for 1957. In that same year the U. S. had 240,000 miles of transmission line at 35 kv and above.

The map, Fig. 1, shows how well the country's power systems are integrated and distributed.

Transmission lines in the U. S. were classified by Edison Electric Institute as follows in 1958:

Nominal Voltage	Circuit Miles, 1958
22,000– 25,000	16,700
26,000– 30,000	3,600
33,000– 36,000	56,500
38,000– 42,000	7,600
44,000– 50,000	28,000
55,000– 60,000	8,800
66,000– 75,000	66,300
80,000–100,000	5,900
110,000–120,000	56,000
132,000–140,000	34,000
154,000–165,000	12,000
220,000–230,000	12,400
287,000–288,000	1,700
330,000–345,000	2,067

These transmission systems are now being operated in a grouping of power pools for economy and reliability of service.

Power Pools

Major power pool groupings in the U. S. today, are shown in Fig. 2, and are explained by Nathan Cohn in his discussion of automatic system control problems, POWER ENGINEERING, January 1960. The large Central and South Atlantic group, for example, includes almost a hundred major utilities operating hundreds of individual generating stations. The Pennsylvania-New Jersey-Maryland power pool now has a generating capability of 13,500,000 kw, supplied by 13 utility companies. TVA's capability is now 11,700,000 kw. Other power pools are the five-State Rocky Mt pool; the Illinois Power Co — Central Illinois Power Co — Union Electric interconnections, Chicago

area pool; there are many others.

As pointed out to EEI by C. E. Oakes, this pooling will continue. It ranges from formal organizations to informal exchanges, or power purchase agreements. Sometimes there is actual interchange of power; in other cases the interconnection provides reserve capacity; in still others the interconnection supplies peaking power only.

An outstanding instance of the way in which an increased interconnection served is given in the next article. One utility had analyzed its system, decided upon a "bare-bones" steam plant to serve its peak load, and then discovered that a neighboring utility would be able to supply its peak requirements. This permitted deferment of not only the low-cost peaking plant but also of a projected large capacity, high-efficiency unit.

Influence of difference in time zones between systems may also affect peak power through interconnections. Classic example of this is the submarine cable across the English Channel, which will interconnect the power systems of England and France. Peak load hours in these two countries are far enough apart so that one can help the other, the English system being largely steam, the French heavy on hydro.

Total December peak load of utility systems in the U. S. was about 122,000,000 kw in 1959, the total capability being 159,000,000 kw resulting in a gross margin of 30.2 per cent. (In 1950 the margin was only 10.3 per cent.) Summer peak was about the same, held up by air conditioning and other new loads in certain areas.

System Control by Computers

As Cohn and other authors pointed out in the section on Automation in the January issue, ultimate goal is complete automatic control of entire systems by computers. This is already being started in individual plants. Also, a number of utilities are now making computer studies of their systems to determine how best to supply peak load power, whether by pumped storage or hydro or thermal plants.

In some cases, they set up a mathematical model of the system on the digital computer, then analyze the system by operational gaming and Monte Carlo methods.

What does peak load power cost when obtained by an interchange arrangement? According to one engineering consultant, cost of this purchased power consists mainly of a demand charge based on the fixed charge rate of installed capacity required to meet the demand, plus an energy charge. Based on average coal steam plant costs, short-time peak capacity might be purchased for about $20 per kw per year demand charge.

Deferment of construction of generating capacity by purchasing peak power may be an important factor while isolated peaks are growing to be large enough to fit into the overall system expansion program. Each system must appraise future load growth, increasing construction costs, long range economy of deferring capacity.

Some of the large Federal systems are interconnected with the private utility systems for reserve and peaking. Municipal and REA systems have different problems, for they are sometimes isolated, but in other cases they are interconnected. Some private utilities have close relations and ties with REA systems; of course, many of these buy all their power from utilities and are distributors only.

Considering all the above factors, therefore, studies of the need for peaking power should always begin with study of how it can be obtained through interconnections. THE END

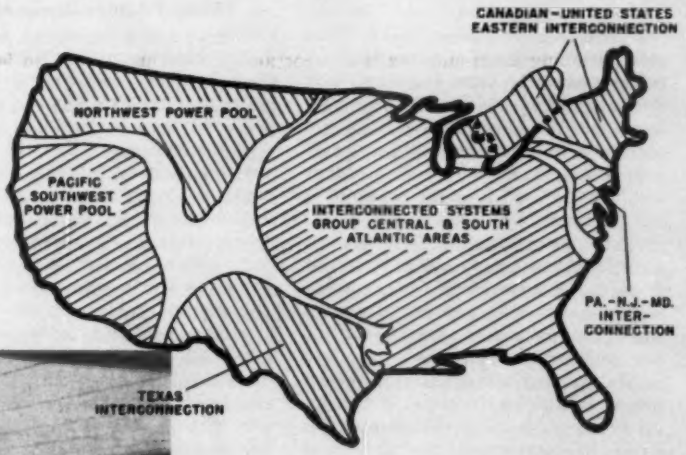


Fig. 2. Area covered by major interconnections and power pools in U. S. These pools are formed and operated for economy, reliability of service

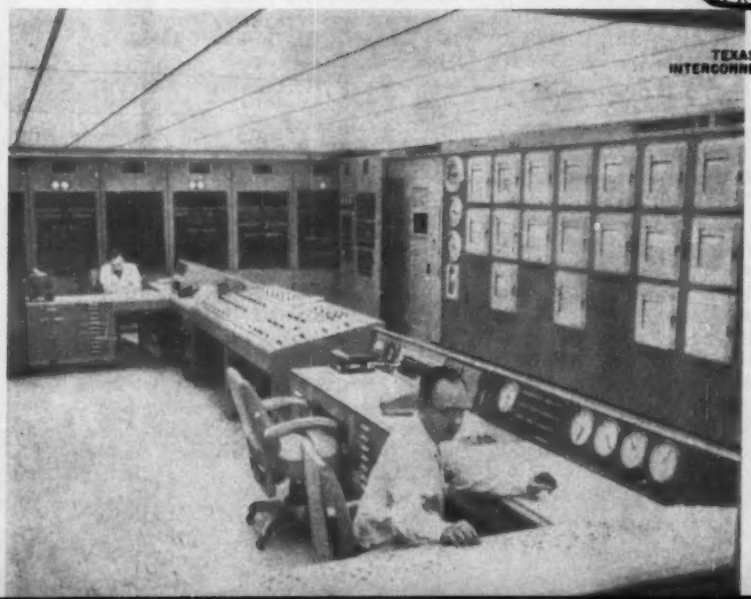


Fig. 3. General view of Florida Power & Light Co's dispatching center. One of newest of the automatic dispatch computer centers being installed. It optimizes company's 10 stations and 26 generating units, controls power flow over company's tie-lines with neighbors

William J. Burns, registered professional engineer, B.S., Carnegie Tech, (graduate work at Carnegie, Univ. of Cincinnati, NYU) is responsible for all mechanical, civil, and architectural work in LILCO's electric, gas and common plant projects. He is active on several committees of ASME, ASTM, AGA, NSPE, ISA.

HOW INTERCONNECTION SOLVED ONE UTILITY'S PEAKING PROBLEM

W. J. BURNS, MANAGER OF MECHANICAL ENGINEERING OF LILCO, TELLS WHY THEY PICKED A 100-MW STEAM UNIT FOR PEAKING AND HOW INCREASED INTERCONNECTION DEFERRED IT

LONG ISLAND LIGHTING CO needed additional peaking capacity on its system because of the economics associated with an annual load factor under 50 per cent and with conditions existing at peak load level of 1000 Mw, when 300 Mw occurs for less than 1000 hours and 100 Mw for less than 100 hours. Under those circumstances, a low-cost steam electric peaking unit was a most desirable project.

But it has not been built. This seeming anti-climax is important because it is at the same time a perfect illustration of the benefits resulting from an interconnection and an explanation of why, without the interconnection, a low-cost steam plant would have been best for peaking on our particular system.

Long Island Lighting Co's need for additional peaking capability stems from the characteristic of its energy requirements that results in an annual peak so severe that the top 20 per cent of the load lasts only 140 hours per year. Substantial improvement of this condition is not considered likely, so for the foreseeable future it would appear that the equivalent of one-fourth to one-third of the system capacity will be required only for peak load generation and reserve commitments.

Thus a point now has been reached where adherence to the previously-followed program of installing 185-Mw reheat units at two-year intervals would be expected to consign relatively new high-pressure, high-temperature machines to peaking service by 1962. Studies have indicated that economic benefits would result from having available in 1962 sufficient additional low-cost peaking capability (about 100 Mw) to match the company's annual load growth plus associated reserve requirements. Substantial present-worth savings would be realized by a one-year postponement of major capital expenditures for a large reheat machine and subsequent machines. In addition, the load factor on equivalent existing reheat capability would be improved.

Many Factors Reviewed

In reaching a conclusion regarding justification for seriously considering the voluntary addition of specific peaking capability, the company has reviewed many factors, including those listed below.

1. Analysis of plant and system heat rates to determine the relationship of new peaking capability to existing equipment on the system.

2. Determination of the trend of annual operating time for a peaking unit installation.

3. Determination of the trend of increased annual system operating costs resulting from installation of a peaking unit.

4. Estimation of capital cost for peaking generation and for future efficient, high-pressure, high-temperature conventional installations.

5. Determination of annual fixed costs for charges on capital investment and operating and maintenance labor for various installation plans, taking into account the size, operating characteristics and sequence of all units under consideration.

6. Comparison of these installation plans based on cumulative present-worth values of annual fixed costs and annual fuel costs for a 35-year plant life.

7. Recognition of the effect of price escalation on the comparative values.

Extensive economic loading studies of predicted operations for a ten-year period beyond 1962 have indicated that capacity added for peaking purposes would operate an average of 250 hours per year for annual peak loads and maintenance outages of other units. This limited annual operation establishes minimum investment as the major criterion, with the attainment of low fuel and operating costs as a minor consideration. In a conventional unit, the economic balance between initial plant costs and fuel costs must be determined very carefully; for example, in the case of an efficient unit operating 4500 hours per year, approximately one-half the cost of power at the station bus is determined by the plant cost, while the remaining one-half is largely determined by fuel costs.

In the case of a peaking unit, the relative importance of original plant cost is multiplied many times, and fuel costs assume a very secondary role, about in the order of 10 to 1. Thus the all-important factor becomes the development of a low-cost plant.

Approaching the problem of providing peaking capacity at minimum cost requires application of a new concept in power station engineering. With the prime thought that capital costs must be the lowest attainable, a "bare-bones" design must be developed, but sacrifice of spare auxiliaries, alternate circuits and reserve margins must not be permitted to decrease the reliability or safety of the installation. Although peaking capacity might operate only a few hundred hours annually, it will possibly be called upon to operate many times

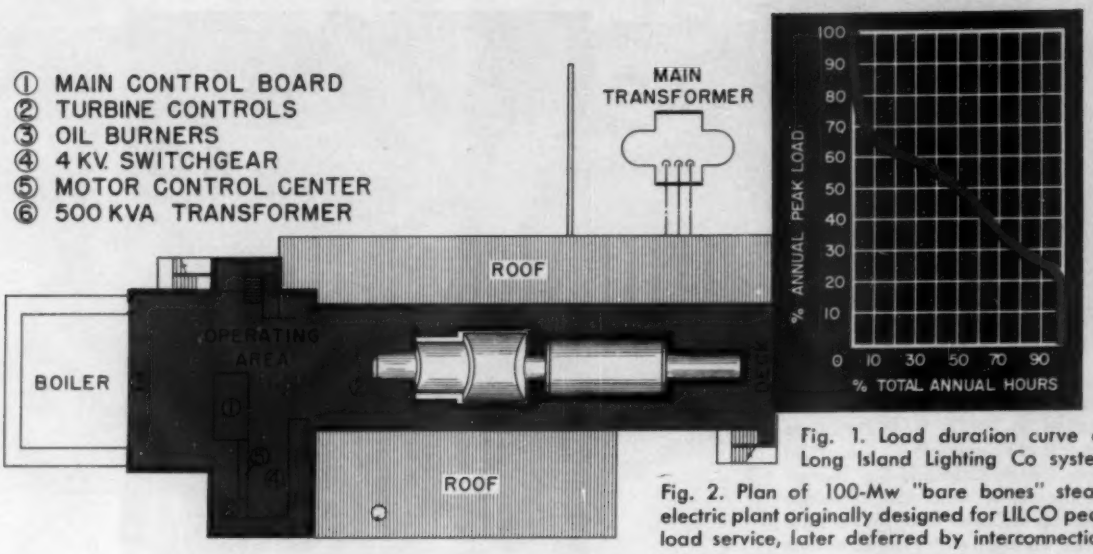


Fig. 1. Load duration curve of Long Island Lighting Co system

Fig. 2. Plan of 100-Mw "bare bones" steam electric plant originally designed for LILCO peak load service, later deferred by interconnection

for a few hours in each instance. Therefore it must be designed for and capable of fast, frequent starting and shutdown. In addition, the limited operation requires careful consideration of the operating manpower requirements.

Alternate Peaking Sources

To provide peaking capability of about 100 Mw, equivalent to the annual load growth and related reserve requirements, Long Island Lighting Co considered a number of alternate sources of electrical energy, in addition to utilization of an existing interconnection with a neighboring utility. Plans for installation of new capacity involved studies of diesel generators, gas turbines and steam electric units for 1962 operation.

Diesel generators had the favorable characteristic of extremely rapid starting, affording the possibility that, in addition to furnishing peaking capability, there could be reasonable argument for treating the capacity as spinning reserve even though idle. However, diesel generators were available only in 2000-kw units, which meant that a base plant must be composed of multiple individual blocks of four 2000-kw supercharged machines coupled to a common electrical control center.

A gas turbine plant also was considered. For review purposes, an installation of two simple-cycle, distillate-oil-fired gas turbines, having a combined winter output of about 50 Mw, was established as the basic unit. Two such plants would be required to provide the desired 100 Mw of peaking capacity.

In addition to diesel generators and gas turbines, dual-incremental peaking steam turbine generators were reviewed as attractive means of providing peaking generation. This equipment would afford short time overload with minimum departure from conventional design. Several methods could be utilized for obtaining approximately 50 per cent more capability than the base efficient unit.

Steam flow through the turbine could be increased by lowering the inlet steam temperature and raising pressure. Alternatively, steam flow through the turbine could be supplemented by generating additional steam in the boiler and bypassing it around the high-pressure turbine to the reheat section. Efficiency would be sacrificed in attaining this peaking capability. However, the installation cost would be much less than for equivalent capacity of the usual design, for during short-time overload periods the design margins in the equipment could be utilized fully without endangering reliability or safety.

Finally, investigations were made of low-cost steam electric peaking units. Cost studies substantiated by manufacturers' quotations demonstrated that a low-pressure, low-temperature installation, which would include minimum heat recovery equipment, limited structures and single auxiliaries, would compare favorably with the other proposals that had been analyzed. With cost differentials thus discounted and after taking into account location, number and complexity of units, noise, operating experience and other factors related to the various alternatives, it was concluded that a steam-electric installation would be the most suitable for the company's requirements.

After considering and rejecting as uneconomical the possibilities of employing supercharged and marine boilers to effect cost savings, evaluation of steam cycles showed that the minimum cost plant would be achieved by employing an 850-psig, 900-F non-reheat steam turbine, oil-fired, pressurized steam generator with one forced-draft fan and no air heater, one feedwater heater and single full-size boiler feed, condensate and circulating water pumps. Best heat rate of such an installation would be expected to be about 14,000 Btu per kwh, but total fuel consumption would be low because of the anticipated limited operating period.

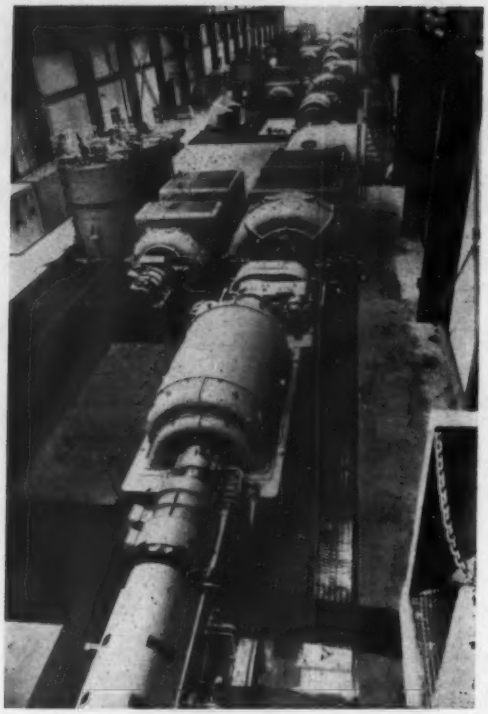
Final Solution

As noted above, use of an existing interconnection with a neighboring utility had been considered as a means of meeting peak loads. Prior to final action on construction of the low-cost steam plant selected by the economic studies, the capacity of the interconnection was increased to 300 Mw. In addition, the wide diversity in occurrence of system peak loads that had developed in recent years now made it feasible to separate the contract year into two parts for purposes of capacity interchange, and permitted the purchase of capacity for the peak period when needed at less cost than fixed charges on a new unit. Economics thus favored indefinite postponement of peaking plant installation plans.

In the future, however, if system loads and cost of capacity indicate the economic feasibility of reactivating the peaking unit project, new studies will be required. THE END

One of first two-speed reversible Allis-Chalmers pump-turbines was installed in 1954 in this Flatiron Power and Pumping Plant, important component in Colorado-Big Thompson project in Colorado. It pumps water up to Carter Lake for storage; stored water operates unit as turbine to generate up to 8500 kw capacity

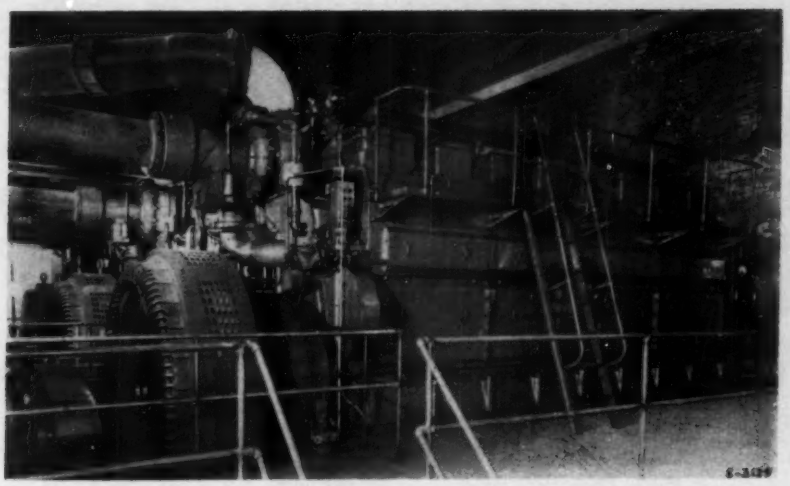
TYPICAL PEAKING UNITS



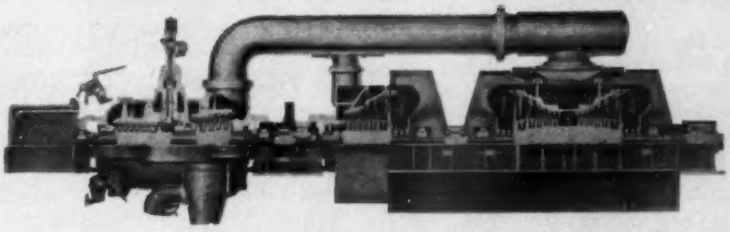
Four 25,000-kw Brown Boveri gas-turbine generating units form large gas turbine plant for British Columbia Electric Co at Port Mann. Using natural gas fuel, they serve as peaking and emergency units in a hydro system. Installed for $128 per kw, including controls; and remotely controlled from Vancouver, 15 miles away

Self-contained 750-kw Solar gas-turbine auxiliary generator set used in several installations, and advocated as suitable for peak load service, costs $110 to $120 per kw, exclusive of transport and installation

Senator Hickenlooper of Iowa dials A-M-E-S on radio transmitter, sending control impulse to start General Motors 2000-kw peaking and emergency diesel plant of Iowa EL&P at Ames, Iowa. At right, Sutherland Dows, president IEL&P. Occasion was dedication of this new plant July 8, 1960



Four 1150-kw, 360-rpm Worthington diesel-engine generating units installed for peaking service in Oskaloosa, Iowa plant of Iowa Power & Light Co; typical of many peaking units throughout the Midwest



Cross-section of spinning reserve turbine for peak-load generation, advocated by General Electric Co to give increased capacity above base load by increasing steam pressure, but at a considerable sacrifice of efficiency

New self-contained, automatically controlled gas-turbine generating plants, in ratings of 3000, 7000 and 12,000 kw, called Econo-Pac plants and designed for peaking, reserve or emergency operation, now available from Westinghouse at installed cost of $80 per kw (winter operation), $100 per kw (summer operation). Mounts on slab

This 600-kw White diesel generating set provides peak load power to meet fluctuating demands for steam and electricity at Falls City Brewing Co, as described in POWER ENGINEERING July, 1960. Brewing processes must be continuous, requiring more steam and power, so less is available for plant's steam turbine generators

Tor Kolflat has been for 6 years a mechanical engineer with S & L on power plant design. After U. S. Air Force service, degree at Purdue University; then worked at Waukegan Generating Station; returned to Purdue for master's degree. He is a registered professional engineer.

STEAM PLANTS FOR PEAKING

TOR KOLFLAT OF SARGENT & LUNDY SHOWS HOW CONVENTIONAL STEAM PLANTS CAN BE USED FOR PEAK LOAD SERVICE AND WHAT THEIR INCREMENTAL COSTS MAY BE

INHERENT SIMPLICITY and flexibility of the steam-turbine prime mover makes it possible to provide electric generating capacity for either base or peak load requirements as dictated by the particular system demands. In supplying base-load capacity, the high load factor justifies the additional first cost of high-efficiency equipment by virtue of the resultant lower fuel and operating costs. Conversely, for low-load factor operation, the importance of reduced fuel and operating costs becomes insignificant compared to the first cost, because of the few hours of operation.

It is possible to economically design and install steam-turbine power plant capacity to meet any predicted load factor requirement, after the future load requirements are determined and stated.

Peak Capacity in Existing Units

Various design and manufacturing margins are incorporated in major steam power plant equipment such as boiler, turbine generator and associated equipment; these margins are provided to insure the equipment meeting the specified capacity and performance. After the equipment is in operation, it is sometimes found that additional capacity is available by virtue of these margins.

For an installation already completed, there is no better way to determine such available peak capacity than through a test program. During such tests, the operating problems, as well as details of equipment performance, should be analyzed in conjunction with the respective equipment manufacturer to establish a reasonable short time peak capacity as distinct from continuous maximum load limits. In most such tests, it may be found that certain specific pieces of equipment constitute the limitation and these limitations might be extended at comparatively small expense in relation to the value of the extra capacity obtained. There are many examples of such successful uprating of equipment after installation.

The equipment manufacturer is naturally not always willing to support such peak uprating, for it reduces the margin built into the equipment, but if the tests are conducted on a thorough and detailed basis, the

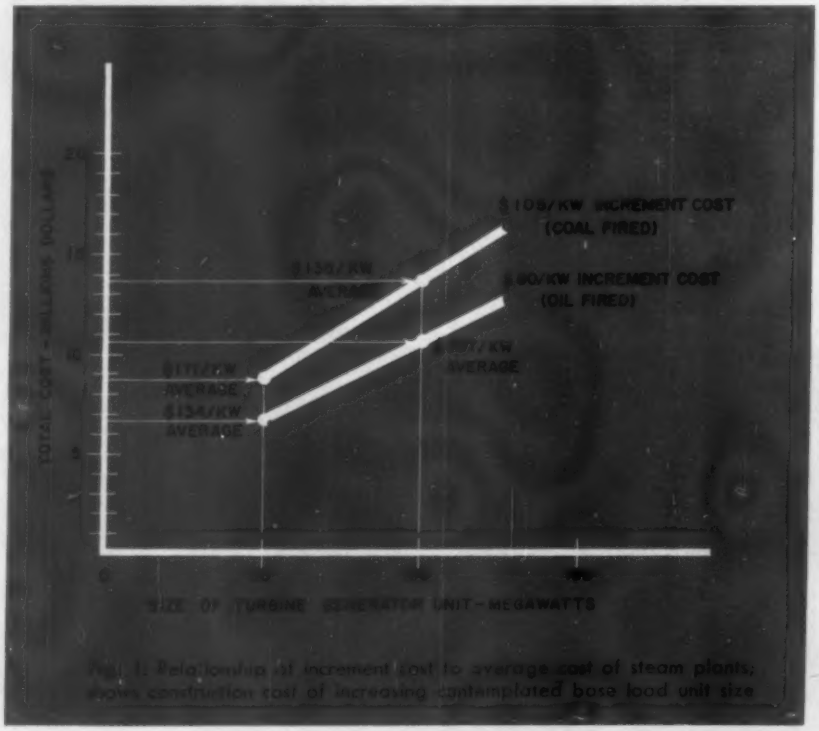


Fig. 1. Relationship of increment cost to average cost of steam plants; shows construction cost of increasing contemplated base load unit size

manufacturer will be able to give a substantiated opinion as to where risk is involved, and where there is no unreasonable risk, in occasional overloading. The different failures that actually occur in power plant equipment illustrate, however, that, in spite of all calculations, there is still a territory of uncertainty or ignorance, and the owner must accept the risk.

Peak Capacity in Base Load Units

Many factors determine the installed cost of conventional steam turbine units. Besides prevailing construction and equipment costs, over which the purchaser has little, if any, control, such criteria as size of unit, type of fuel, throttle steam conditions, type of cycle and equipment included in the plant will affect the total plant cost. In all cases, though, the cost of increment capacity is about 20 per cent to 30 per cent less than the average cost of a conventional steam power plant, and it might be well to review the comparative merit of peak capacity as an increase in size of contemplated units instead of separate peak units.

Total construction cost of adding 50 Mw, 100 Mw, and 125 Mw units to typical coal and gas or oil-fired stations is plotted in Fig. 1. Identical steam conditions of 1450-psi 1000/1000 F, equipment included, etc, have been considered for each curve. The only variable affecting cost is the unit size. A similar plot can be made for other unit sizes.

Referring to Fig. 1, assuming a 20-per-cent increase in the size of the oil-fired unit from 100,000 kw to 120,000 kw, the cost for the additional 20,000 kw is in the order of $80 per kw as compared to the average cost of $107 per kw for the 100,000-kw plant. This indicates there is a considerable decrease in increment cost for increase of a given unit; such increment could be considered as a peak capacity just as well, and will be of the same quality and efficiency, as the base capacity.

Low-Cost Steam Plants

Where a large amount of peak capacity is required only during three to four months, and could be completely shut down for eight to nine months, it would seem economical to design some low-cost, low-efficiency units, sacrificing stack temperature, and feedwater heating, vacuum and the like. Study made for a 100,000-kw gas- or oil-fired unit indicates approximately 20 per cent saving in capital cost, compared with an efficient unit of the same size, Fig. 2.

Part of the cost reduction is obtained by using a non-reheat non-regenerative turbine cycle having 850-psi and 900-F throttle conditions instead of a reheat regenerative 1800-psi-1000/1000-F cycle. Stack temperature of the boiler was designed for 500 F instead of 300 F; condenser surface was reduced; and only equipment necessary to carry the load was included, with no spare auxiliaries, all contributing to a reduction of installed cost. (More detailed report, Ref 2.)

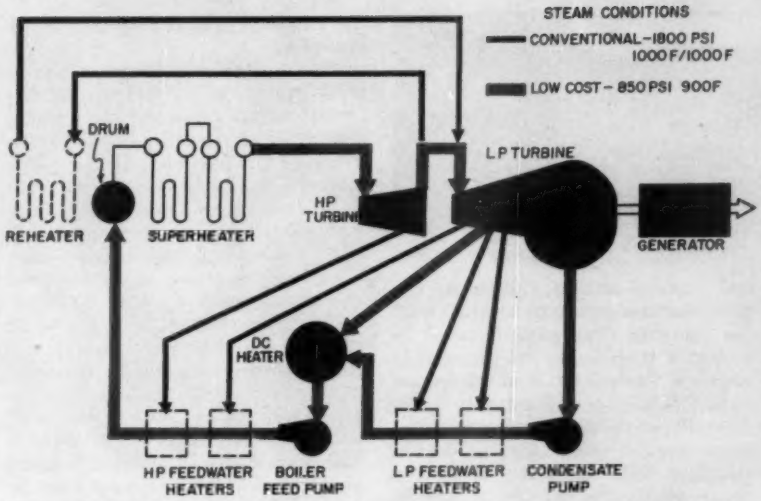


Fig. 2. Comparison of conventional and low-cost 100-Mw steam-plant cycles, latter for peaking. Conventional cycle—black lines. Low-cost cycle—heavy red lines

Built-In New Plant Peak Capacity

For new steam plants that are in the design stage, it is perfectly possible to obtain as much as 10 per cent to 20 per cent short-time peak capacity at a cost substantially below both the average normal and incremental capacity cost, by the following methods.

Shutting Off of Feedwater Heaters: — It is possible to increase output of a given turbine without increasing throttle flow by reducing the amount of steam extracted for feedwater heating, by omitting one or more of the top heaters from service. In a five to six heater cycle, increase in turbine capacity will be in the order of 4–5 per cent for one heater, and if two of the top heaters are taken out, the over-all increase in theoretical capacity will be in the order of 7–9 per cent, which is partly reduced due to loss in efficiency. In most turbine contracts, there are no commitments of the manufacturer to increase the turbine output in compliance with this possibility, but in some contracts it has been specifically stipulated.

Removal of feedwater heaters from service during peak periods has some minor effect on turbine reliability, for it increases the flow of steam through the tail end of the turbine, which, under high-vacuum conditions, may result in heavy turbine-blade stress.

Removal of each feedwater heater from service will reduce the feed temperature by approximately 60 F, and it has an effect on the boiler performance because it increases the steam temperature, for more fuel has to be burned for the same steam flow, due to the lower feedwater temperature. The higher steam temperature requires more high-temperature superheater tube material and more desuperheating if such operation is to extend over any lengthy period. Total heat input to the boiler will also increase in proportion to the load; and, if the peak load occasionally is to be carried for more than a few hours at a time and coal fuel is used, this might necessitate an increase in furnace size.

Increase in boiler equipment capacity necessary for a prolonged period of this type would represent an increment cost of $44 per kw. Total increment cost for such capacity increase, including increase of generator capacity, and the like, would be in the order of $56 per kw.

For peak operation of shorter periods, one may make use of existing margin in the boiler equipment itself and only make provision for an increase in auxiliary equipment required for the boiler, and the cost of this increment capacity may be as low as $10 per kw.

Steam Pressure Increase: — Due to the leeway established in turbine manufacturers' pressure specification, it is permissible to operate turbines at approximately 5 per cent higher pressure than normal for a certain period, and this makes possible 5 per cent increase in steam flow

and turbine output. However, the usual turbine-generator contract does not concede that such increase in output is possible, as the permissible pressure fluctuation is not intended to be followed by an increase in steam flow. Some turbines, however, have been bought under specific understanding that the steam flow, and consequently the capacity, could be increased 5 per cent for peak periods.

In trying to evaluate the cost of peak capacity due to such a pressure increase, it again requires 5 per cent more boiler equipment capacity and 5 per cent increase in generator capacity, and the total equipment increment cost on this basis might be in the order of $63 per kw without making use of available equipment margins.

Bypass of Turbine High-Pressure End: — It is generally recognized that the capacity of a given turbine can be increased by partly bypassing the front end and admitting considerably more steam to the lower stages of the turbine. A small amount of such additional steam flow, in the order of 10 per cent, is almost in the same classification as the previous case, except that it also further reduces the turbine efficiency and, therefore, theoretically requires additional boiler capacity; so the increment equipment cost might be in the order of $70 per kw.

Recent studies have been made by at least one turbine manufacturer contemplating as much as 50 per cent increase in capacity of a turbine by bypassing the front end of the turbine. In this case, the problem becomes somewhat different from bypassing only 10 per cent because the turbine efficiency decreases approximately 10 per cent at full load, which then requires 10 per cent of full boiler equipment capacity in addition to the straight increase in loading. For instance, as the turbine capacity is increased from 200,000 kw to 300,000 kw by this method, the actual increase in over-all boiler equipment capacity must be in the order of 130,000 kw. It also imposes flow rates through the lower part of the turbine that, up to now, have been considered excessive.

Such a high percentage of equipment peak capacity will require different capital increment cost, partly depending on the contemplated duration of the overload. If it is to be used only two or three hours a day on peak days, it will not substantially increase the daily output and it will not require more coal and ash handling equipment, no more condenser and circulating equipment, no bigger feedwater heater, and the like, for no effort is made to maintain high efficiency during such conditions. It will require larger boiler and boiler auxiliaries and piping, and some boiler room building space, in particular if coal is used as fuel, because slagging and related boiler problems must be considered.

Cost of boiler room capacity increase would be in the order of $45 per kw, but, due to the loss of turbine efficiency, actually $45 \times 1.3 = \$60$ per kw will be required. The increased rating in turbine-generator equipment, as well as related electrical items, amounts to approximately $35 per kw. On this basis, total increment cost of the increased 100,000 kw, or 50 per cent increase of a 200,000-kw unit, would approximate $95 per kw, on the understanding that high overload is only for short periods. This larger percentage of increase in unit peak capacity in the order of 50 per cent will not be materially different in cost, whether it is accomplished by bypassing of the high-pressure turbine and consequently reducing the turbine efficiency and thus requiring more boiler capacity or if it is obtained by using a bigger standard turbine, so that the turbine efficiency is not reduced and a corresponding savings will be obtained in the boiler capacity to compensate for the cost of a larger standard turbine generating unit.

Change in Fuel During Peak Hours: — Difference in plant cost between gas firing and coal firing is of the order of $35 to $40 per kw. This is partly due to the larger boiler equipment required for coal firing. When a unit is designed for coal burning, it is possible, with a small increase in capital cost, to arrange for gas or oil for greater output during peak hours, and thus increase the capacity of the boiler, if proper adjustment is made in the original design.

Cost of such increment peak capacity depends entirely on how it is accomplished. It will cost less if obtained by partly bypassing high draft equipment, and so on. Twenty per cent more increase in boiler capacity could be obtained by change in fuel at a cost of $15 per kw if the main boiler size is not changed. The turbine-generator peak capacity could be obtained for $30 per kw or a total of $45 per kw for the plant increment cost. Naturally, fuel cost would be higher during the period when oil or gas is burned.

Summary and Conclusion

In conclusion, many methods of obtaining peaking capacity are available and a comparison of installation cost for various types of capacity available indicates that for new steam plants which are in the design stage, it is perfectly possible to obtain as much as 10 per cent to 20 per cent short-time peak capacity at a comparatively low cost.

For conventional steam-turbine unit power plants, there is considerable decrease in increment cost for increase of a given unit and such increment could be considered as a peak capacity just as well, and will be of the same quality and efficiency, as the base capacity. In the design stage the increment cost of conventional steam-turbine plants can be reduced further for peaking. THE END

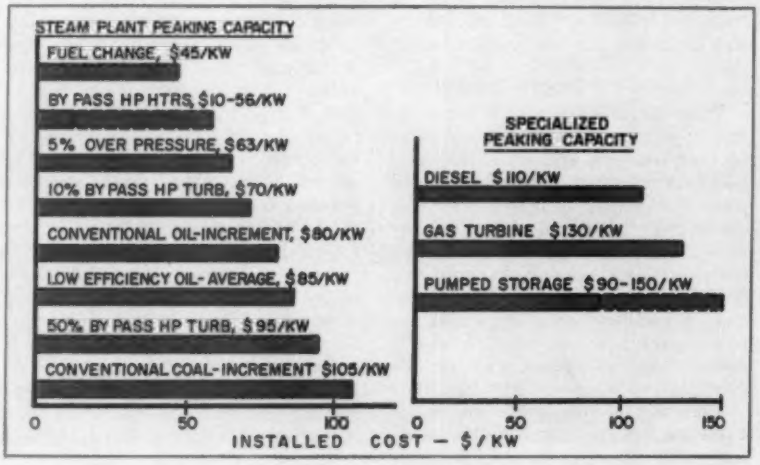


Fig. 3. Installed costs for various methods of supplying peak-load capacity

Earle R. Webster, vice-president of Bangor Hydro-Electric Co, is an electrical engineer from the University of Maine. He joined the company in 1927, has been successively construction engineer, assistant general manager and manager of operations. He is active in many of Bangor's civic and organizational affairs.

HOW WE PICKED DIESELS FOR PEAKING

EARLE R. WEBSTER OF BANGOR HYDRO-ELECTRIC CO. EXPLAINS THEIR ANALYSIS OF STEAM, HYDRO, DIESELS AND GAS TURBINES TO ARRIVE AT DECISION TO USE DIESELS

FOUR DIESEL generating units of 2000-kw capacity each were installed in June on the Bangor Hydro-Electric Co system at Medway, Maine for peaking capacity and end-of-line operation.

Bangor Hydro-Electric Co provides electric service to about 70,000 customers in Hancock, Penobscot, Piscataquis and Washington Counties in northeastern Maine.

Starting out as a 100-per-cent hydroelectric generating system in 1925, load growth over the years has called for additional generating capacity, and the first thermal units were installed in 1949 and 1950, when six 1000-kw slow-speed diesels were installed. These units were placed at three different locations with 2000 kw at each, and serve as peaking units, voltage regulators and as emergency service units for their service area. Additional generating requirements have been met by installation of a 5000-kw gas turbine in 1950, a similar unit in 1952, a 12,500-kw steam turbine in 1954, and an 18,000-kw steam turbine in 1957. These units, having a total capacity of about 40,000 kw, were installed at the system load center near Bangor.

System load centers are basically the Bangor area with about 60 per cent of the total, the northern section with Lincoln as the center with 20 per cent, and the eastern area requiring the balance or 20 per cent. The northern and eastern territories are larger, and the loads are divided into small areas served by 44-kv transmission systems with substations located in the smaller load centers. The major parts of this transmission system are road-side construction and subject to highway hazards.

The 44-kv transmission system connects the various generating plants and load centers of the system and in several cases is the only source of service to an area. The original diesel installations at Eastport and East Machias provide end-of-line power in the Washington County area.

In 1930 a tie line operating at 115 kv was built between Veazie and Bucksport, connecting the Bangor Hydro system to the Central Maine Power Co system. This tie line has a capacity for the interchange of 20,000 kw between the two systems. This line is normally operated on a balance, but has also been used to provide emergency power for both systems and as a feeder for the sale of surplus power.

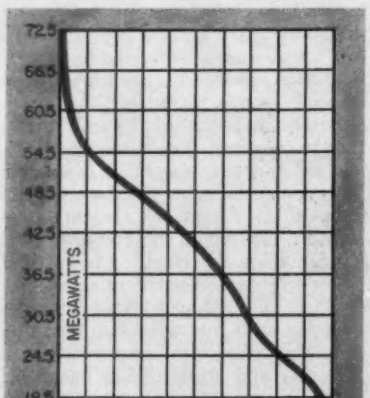


Fig. 1. Load duration curve, Bangor Hydro-Electric Co system for 12 months ending April 30, 1960

System Studies

A system study made in 1954 indicated the need for a transmission line from the system load center in Veazie to Washington County. Several voltages, wire size, and types of construction were considered, and in 1957 a 115-kv transmission line, with 4/0 conductors on H-frame construction, was put into operation.

In 1957 a study of the northerly section of the system indicated the need for additional power or a new transmission line into the Lincoln area by 1960.

Early in 1959, system load and generating capacity indicated a need for additional generation. Load duration curves were studied and it was very apparent that the existing hydro units together with the efficient steam units would take care of the base load of the system. Installed diesels and gas turbines could take care of loads above the base; but the need for capacity over the peaks and for a limited number of hours each year would be necessary in 1960.

In the past, utilities have found the most economical method of meeting

HOW WE PICKED DIESELS FOR PEAKING

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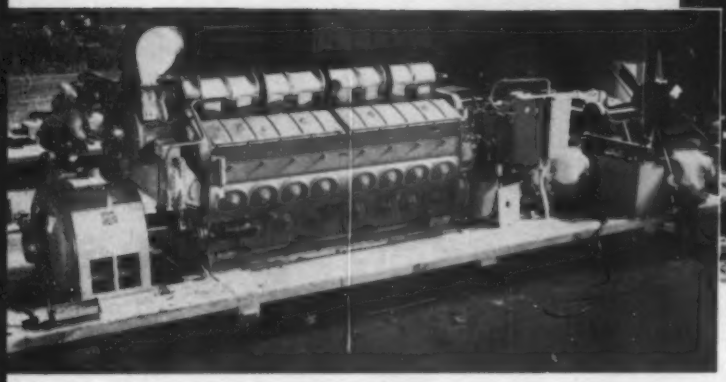

Fig. 2. This view shows one of the 2000-kw supercharged diesels in shop

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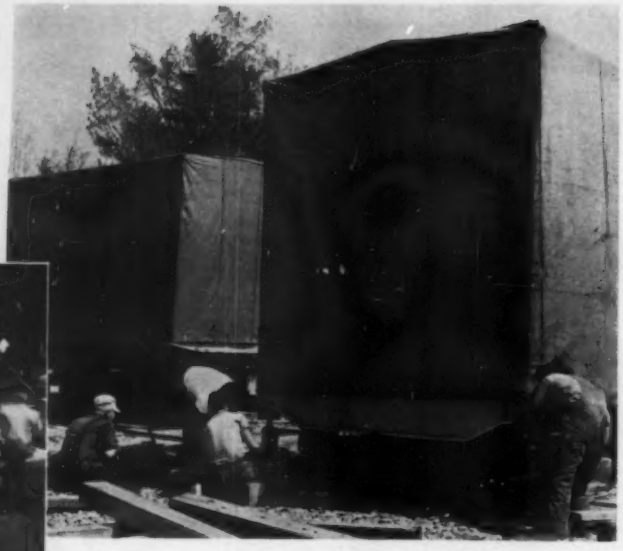

Fig. 3. Each engine was placed on foundation of crushed rock and railroad ties

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Fig. 4. Individual engines in housing were delivered by truck to Medway

load growth by installing large, efficient base load plants and using older and less efficient generation for peaking and low load factor operation.

Peak load growth in the Bangor Hydro system averages between 6000 and 8000 kwh per year. The major part of the total kwh is produced by hydro generation, with the steam units providing a large part of the balance.

Engineering and economic studies were made in 1959. The following methods of providing additional generating requirements were considered:

A. Addition of preferred standard steam units at the system load center in 1961 and 1966.

B. Addition of a peaking steam plant in 1961 and a preferred standard steam plant in 1965 or 1966.

C. Addition of diesel peaking units starting in 1960 with similar installations as needed, with a preferred standard steam plant in or about 1966.

Many factors were considered in the study, including fixed charges, operating costs, size of units and location.

Plan A was favorable as to operating costs but would have higher fixed charges over a period of years when the total capacity of the unit would not be required. To obtain good efficiency and low operating costs, the unit should be in the 20-Mw class and located in or near the system's load center. This would require additional transmission line capacity to transfer the power to the outlying areas.

Plan B reduced fixed charges slightly with increased fuel cost and has the same problems related to location and transmission lines.

Diesel plan C was adopted and, by locating the units in Medway, at which location there is a hydro plant with operators on duty at all times, we made it possible to add a dead load pickup feature, to provide emergency service to the surrounding area in the event of system troubles, or when the transmission line connection was interrupted.

The Medway installation consists of four generating units and one control unit. Each unit is in an individual house about the size of a freight car.

Control Unit

The control unit contains the switchgear for each generating unit, generator controls, protective relaying, automatic synchronizing and loading controls, starting battery, chargers and power take-off connections. Switchgear is drawout 250-Mva air circuit breakers in dead-front metal-clad cubicles.

The units can be operated from the control unit or from a remote control panel located in the Medway Hydro Power House. The remote panel has controls for each unit together with a control for starting all units in case of a power failure. Metering for

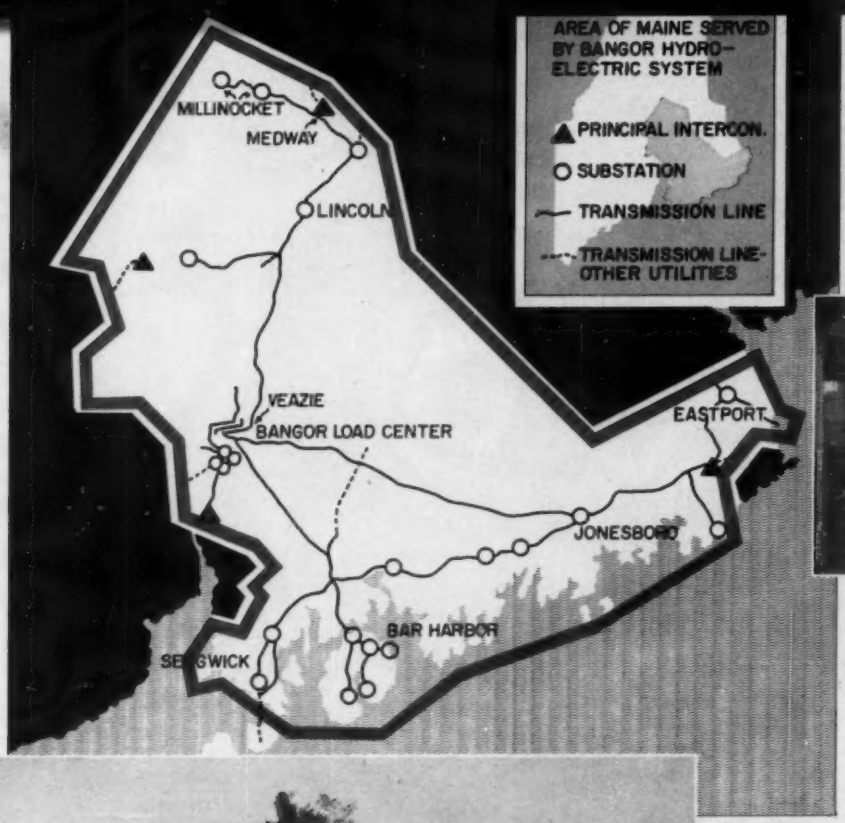

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Fig. 5. Map showing 115-kv and 44-kv transmission system of Bangor Hydro-Electric Co serving four counties in Me.

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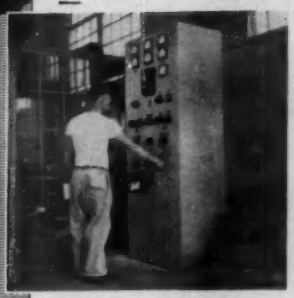

Fig. 6. In the Medway hydro plant, the operator, Gene Pelkey, puts the diesel plant on line

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Fig. 7. View of diesel plant at Medway, Maine; 2 engines in place; 2 others plus control house under erection

voltage, current and kwh is also provided on the remote panel.

Each generating unit consists of a 16-cylinder General Motors EMD, supercharged diesel engine directly connected to a 3-phase 2500-kva alternator; a static type exciter is used. The entire assembly is referred to as an MU 80 plant.

A closed engine cooling system, with an engine driven vertical fan, radiator air filter, and automatic temperature control, is installed in each unit. A 24-kw immersion heater, using bus power, is provided to keep oil and water temperatures up for fast starting.

Installation Details

All the units are mounted on fabricated steel bases, with provisions for lifting and jacking, and are enclosed in sound-insulated, weather-proof steel enclosures.

Foundation for the units was made up of crushed rock about three feet in depth, with treated wood ties placed for the units. Trenches for power, and control cables between units, were blocked off in the crushed-rock foundation.

The units, shipped on railroad flat cars, were loaded onto a trailer and moved to the site and jacked onto the foundation. Control and power cables were installed and connected. Two 20,000-gal oil storage tanks were installed on the site and piped to the units. The trenches were then filled with sand covered with planking and a final layer of crushed stone.

With four units each having a capacity of 2000 kw, it is also possible to pick up any part of the station capacity for peaking service and operate the units at efficient loads. This peaking plant is under the control of the system operators located in Bangor, 90 miles south of Medway.

In normal operating practice, the dispatcher requests the Medway operator to start and stop the units as needed for system loadings. The units are designed to be started and brought up to full load in ninety (90) seconds, either as individual units or as a complete station. Equipped with an automatic synchronizing device, the Medway operator can start the entire plant with one control switch.

If there is a complete power failure in the Medway-Lincoln area, the units can be started, and will pick up the load with the units dividing the load between them and governing that part of the system. The Medway operator can follow the load on the control panel and stop one or more units if the load requirements do not need the full plant in operation.

With the fast start, and fast load pickup, it has been possible (on a system disturbance) to start one or more diesel units — to stabilize frequency — before the hydro plant went down on low frequency and overload. THE END

MORE ON AUTOMATIC DIESEL PLANTS FOR SUPPLYING PEAK LOADS

Fig. 1 (Above). Automatic peaking and emergency 2000-kw EMD diesel plant at National Animal Diseases Laboratory, Ames, Iowa. Dark cubicle contains the engine and laboratory electrical gear

Fig. 2. Automatic packaged 4200-kw EMD diesel plant for peaking, installed by Maine Public Service Company at Presque Isle, Maine

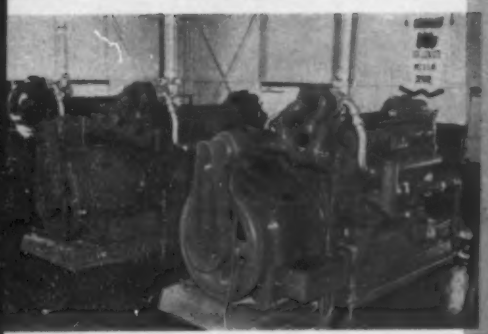


Fig. 3. Carlisle, Ill., has installed 3 Caterpillar Model D 397 350-kw diesels for peaking with steam-electric equipment

RECENT DEVELOPMENTS in the diesel engine field, worked out especially for supplying peak load power on power utility systems, have sparked renewed interest in their use for this purpose. There is nothing new about use of conventional diesel engines for peaking on power systems; they have been so used for years. Several examples of them are shown on these pages. What is new is the complete, packaged, automatically-operating, unattended diesel plant, in capacities large enough to be applicable on many power systems, low in cost, installed quickly and simply, and controlled from a remote point.

Good examples of the use of conventional diesel engines for peaking service abound. Investor-owned systems have used them thus, also on end-of-line service. Municipal and REA systems and some Federal systems in some of their steam-electric plants have used them not only to supply peaking power but also as standby and emergency sources, for keeping steam plant auxiliaries going

in case of system trouble. Many industries and institutions use them for standby power.

Increasing air conditioning load in various parts of the country has produced high summer peak loads, in some cases greater than the December peaks, as pointed out by Glenn Boyer in reporting on a study of six municipal steam power stations. Diesel and dual-fuel engines operate successfully in parallel with steam-driven units. Those six plants use three different makes of engines, both two-stroke and four-stroke, with speeds ranging from 360 to 720 rpm. For peaking service, he recommends dual-fuel operation, especially in the Midwest where peaks occur in the summer when gas is most readily available.

On the other hand, one steam plant, reports Boyer, uses its diesel engine on the winter peak when gas is not available, finding it cheaper to burn fuel oil in the engine rather than to burn it in the boilers to put a second steam turbine on the line.

Sanford K. Fosholt has compared costs of diesel and steam plant generation for plants at 30 per cent annual load factor, showing that for plants satisfying a load demand of 6000 kw and 18,000 kw, diesel generation with oil costs less than steam; but, for a 30,000-kw plant, steam gives lowest cost.

Packaged Plants

The new packaged diesel plants, referred to above, are being produced by Electro-Motive Division of General Motors Corp. They have the following characteristics:

Individual diesel engines of 1000 to 2000 kw capacity may be combined in multiples to form plants of 2000 to 10,000 kw capacity. Each engine can be straight diesel, or supercharged diesel, or dual-fuel. Individual engines are mounted on a structural steel base and enclosed in a sound-insulated, weatherproof housing (or "pod", or cubicle) with radiator, lubricating and cooling equipment and all other accessories in the housing. The "pod" can be shipped on freight cars and trucks to the site as a package and installed outdoors. A separate control cubicle contains all necessary automatic control system equipment.

Engines can have very simple foundations, minimizing installation cost — in some cases, crushed rock and railroad ties, in other cases simple concrete piers. They are cooled by a closed water-cooling system, requiring very little make-up. The plants may be controlled for dead-load pickup.

Based on personal observation by this writer, they are very quiet in operation and free of vibration. They are supplied at factory prices ranging from $82 per kw for a 10,000-kw plant and ranging upwards to $100 for other capacities; installed cost per kw may range from $97 per kw to $110 or $120 per kw.

Typical Installations

One of the first package plants of this type was installed in February 1959 at Plymouth Meeting by Philadelphia Electric Co. It consists of three 1400-kw non-supercharged units and one control unit. These will be replaced by supercharged units, raising their capacity to 2000 kw each. Fuel is diesel oil.

Another such package plant, consisting of three 1400-kw non-supercharged engines and control unit of the same make, was installed outdoors on a crushed rock and railroad tie foundation near Presque Isle, Maine, by Maine Public Service Co. It was described in detail by J. D. Waddell, PoE, Nov 1959, and is shown in Fig. 2.

At Medway, Maine, still another automatic, remote-controlled package diesel plant using supercharged engines of the same make, has been installed by Bangor Hydro-Electric Co, as described in the preceding article.

Figure 1 shows an installation of two 1000-kw Model 16-567 C engines and control cubicle, forming what is designated as an MU28DF plant, which has been installed at Ames, Iowa, by Iowa Electric Light & Power Co.

The engines are dual-fuel units, drawing natural gas from one of the nearby gas pipelines, firing it in combination with diesel fuel.

The plant is located near a new National Animal Diseases Laboratory now being erected at Ames. It serves both as emergency power for the laboratory and as a peaking unit on the Iowa E. L. & P. system. The utility supplies a total of 4000 kw to the laboratory, with 1800 kw of it "preferred" with no interruption more than 5 min; also a supply of fuel oil and natural gas for the laboratory's own use.

The plant operates as follows. One 34.5-kv transmission line comes from the utility system to the laboratory from the north, another from the south. If an outage occurs on the south line, and first attempt at reclosure fails, an automatic signal from the utility system actuates a 30-sec waiting cycle in the diesel plant. Then the engines start automatically and come to full speed immediately. If both high lines are out, a second automatic signal closes the plant breakers and the unit takes full load. If either high line holds, the diesel plant continues to run for 3 min, then shuts down automatically.

Control for Peaking

To put the plant into operation for normal peaking operation, a signal is transmitted from Boone. When the high lines are restored after an outage, the diesel plant re-synchronizes with the system, converts back to peaking operation and runs until shut down by a signal from Boone.

Fuel is normally 90 per cent gas, 10 per cent diesel fuel. If gas pressure falls or is lost, the engine switches automatically to diesel fuel. It also switches to diesel fuel for emergency operation. On return to normal operation, it returns to dual-fuel operation.

The engines in this plant are supported on simple concrete pedestals as shown in Fig. 1, instead of the rock and tie foundations.

The manufacturer of the above package diesel plants has just announced a new MV-100 plant, for a capacity of 10,000 kw, to sell for $82 per kw at the factory. It uses the Model 567D turbocharged engine generators. THE END

Fig. 4. These two 2500-kw Nordberg diesel generators provide peaking capacity for a large eastern utility

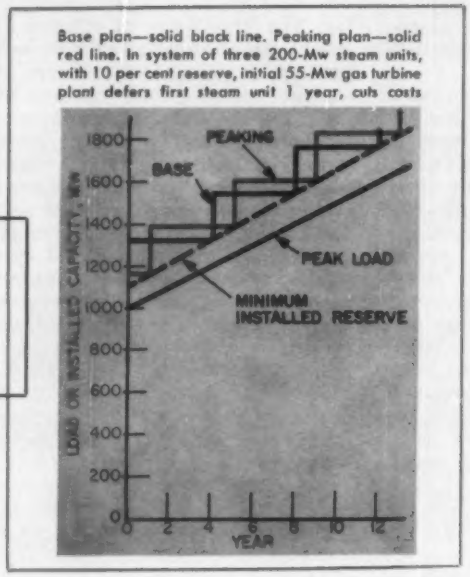


Fig. 1. Future load and capacity patterns by Stephens and Lloyd of Westinghouse, for model power system

GAS TURBINES, TOO, MAKE EXCELLENT PEAK-SHAVERS

AUTOMATIC AND REMOTE CONTROL, QUICK STARTING, LOW MAINTENANCE FIT THEM WELL INTO SOME UTILITY AND INDUSTRIAL SYSTEMS

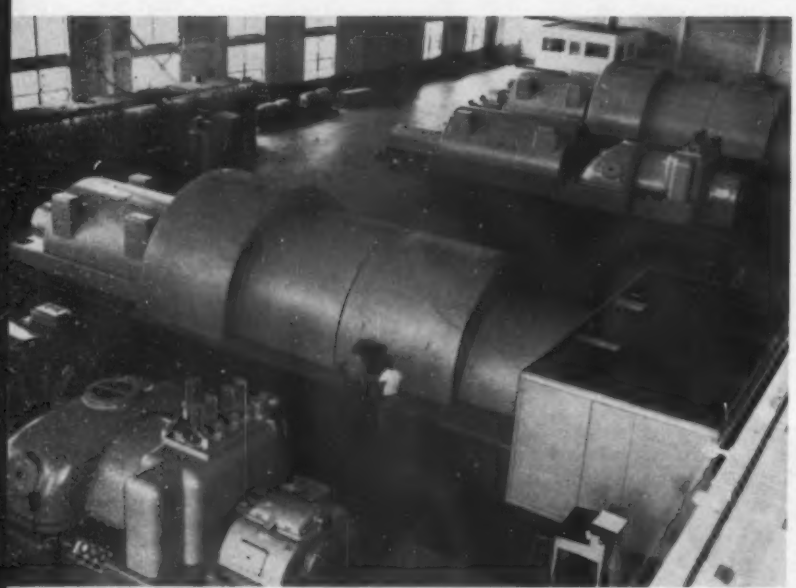


Fig. 2. At Municipal Power Station, Orlando, Florida, these two 16,500-kw General Electric gas turbines, in main steam turbine room, supply peak-load power to system. Burn distillate oil or natural gas; go on line 20 min from cold; operate 3 or 4 hours per start at about 17,400 Btu per kwh

DURING the past 15 years the gas turbine has become well established as our fourth prime mover. At latest count, July 1959, there were about 550 stationary gas turbines installed world-wide, with a total capacity of approximately 1,900,000 kw. This does not include the many marine, locomotive and aircraft gas turbines.

Most of the stationary units are on conventional base load generating service, or on pipe line compressors or in chemical and refinery processes. However, within the past few years, power utilities have encountered new aspects of the peak load problem. Many have selected gas-turbine generators to solve it, as shown in the accompanying table, at reduced fixed and operating costs, after careful analysis of the possibilities of steam, diesel and hydro units.

Recent Developments

First peaking units, installed 10 or more years ago, were in capacity ranges of 4000 to 6000 kw and, of course, some of the recent ones are of that order. For large power systems, they are not big enough, although they do fit smaller private and municipal systems. Recently, however, the

Table showing data on typical gas-turbine generators for peak load. All simple open-cycle units. NEMA conditions: 180 F, 1000 ft altitude

User	No Units	Rating, Each, Kw	Fuel	Manufacturer
Williamson Diamond Mine, Tanganyika	1	950	Diesel Oil	Ruston & Hornsby Ltd
Princetown, England	1	3000	Distillate	Bristol Siddeley Engines, Ltd
Electricité de France, St. Dizier	1	6000	Fuel Oil	Brown Boveri Co
EDF, Tours	1	6000	Oil, Free-Piston Gasifiers	Sigma & EDF
EDF, Cherbourg	1	6000	Oil, Free-Piston Gasifiers	Sigma & EDF
EDF, Angers	1	6000	Fuel Oil	Société Rateau
Electricidad De Caracas	1	21,500	Gas & Oil	Brown Boveri Co
City of Moorhead, Minn.	1	10,000	Oil & Gas	Brown Boveri Corp
Philadelphia Electric Co	1	22,000-27,000	Gas-Distillate	Westinghouse Electric Corp
Beirut, Lebanon	1	5000	Diesel Oil	" " "
City of Austin, Minn.	1	5500	Oil & Gas	" " "
City of Larned, Kans.	1	1250	Oil & Gas	" " "
Port Mann, Brit. Columb.	4	25,000	Oil & Gas	Brown Boveri Corp
Bangor Hydro-Electric Co	2	5000	Oil	General Electric Co
Central Vermont P S Rutland	3	5000	Oil	" " "
Central Maine Power Co Farmingdale	1	3500	Oil	" " "
Orlando Utilities	2	16,500	Gas-Distillate	" " "
City of Monroe, La.	1	10,000	Gas	" " "
Central Vermont P S Co	1	20,500	Distillate	" " "
Philadelphia Electric Co	1	20,500	Gas-Distillate	" " "
Montana-Dakota Utilities	1	4000	Gas-Distillate	" " "
New Orleans W & S	1	20,200	Gas-Distillate	" " "
City of Regina	1	17,800	Gas-Distillate	" " "
Electricidad De Caracas	1	21,500	Gas-Distillate	" " "
Hydro-Quebec, Gaspe	6	6000	Oil	" " "

Fig. 3 shows 7400-kw Brown Boveri peaking gas turbine generator in municipal utility plant, Moorhead, Minn.

manufacturers have been able to build units first with capacities up to 16,000 kw and now of capacities ranging between 20,000 and 27,000.

Moreover, recent developments include possibility of combining components so that the gas turbine plant can have a maximum capacity of 150,000 kw with a single generator, similar to steam turbine practice. A peaking plant of this size could later be combined with a steam plant to form a combined cycle plant of 1300 Mw capacity, for a 3 to 4 per cent gain in thermal efficiency.

In short, it will be possible to cover the entire size range for both peaking and combined-cycle plants. Present units are all of the simple, open-cycle type, without regeneration or intercooling, and this keeps the costs down to ranges between $80 and $110 per kw installed. The gas turbine for peaking, therefore, not only competes in cost with the diesel, but the larger gas-turbine sizes fill the gap between the peaking diesel plant and the very large, highly-efficient reheat steam-turbine generators.

As previously pointed out, careful system analysis shows whether or not the peaking gas turbine is applicable. One of its principal advantages is that it may defer the installation of high-efficiency steam units, hence their large capital investment. For example, Stephens and Lloyd of Westinghouse, analyzing a proposed system of three 220-Mw steam units, showed in Ref 10 how an initial installation of gas turbines made worthwhile savings.

First, a 55-Mw gas turbine plant (two 27,500-kw units) would be installed at $95 to $110 per kw; this would defer the installation of the first 220-Mw steam unit for one year; the other two would follow at intervals of 4 years, Fig. 1. Over 12 years, present worth of the peaking plan would be $1,980,000 less than that of the base plan. Production costs also would be less. Operating advantages, such as start-up in 20 min, less attendance, lower maintenance, vary with systems and are hard to evaluate.

Another detailed analysis by General Electric on a system of 150-Mw coal-burning steam units, with a winter peak, shows that oil-fired gas turbines costing $109 per kw installed would have credits such that the effective gas turbine plant cost for peaking would be much less. The analysis considers capitalization rate, coal and oil costs, heat rates and all other factors, including a fuel penalty, and shows that the total effective cost of the gas turbines is $82.94 per kw.

Combined Cycle

Many of the peaking gas turbines installed and on order have been planned with the combined cycle in mind. Boilers can nowadays be designed for pressurized operation, so that the gas turbine exhaust can serve as combustion air for burning fuel — an idea advocated for some time. Plant Crisp, Ref 19, was one of the first to combine the gas turbine and steam turbine in this way. Gas turbine exhaust for heating water in an economizer of a steam cycle was an early use of the exhaust.

On the whole, the combined gas-

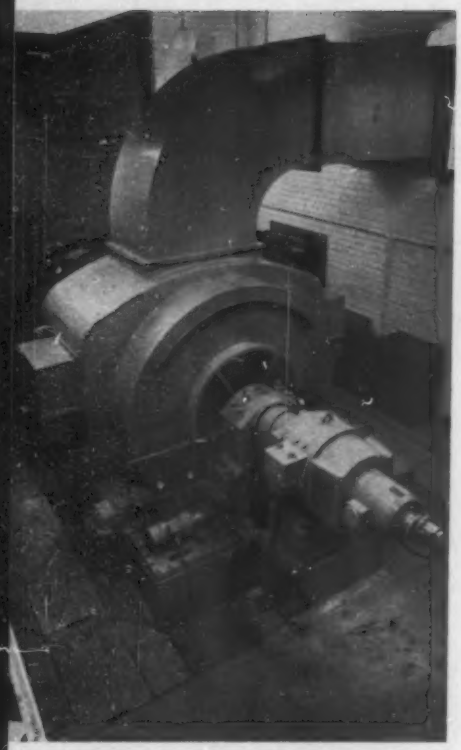


Fig. 4. Automatic, unattended Bristol-Siddeley 3000-kw, remote-controlled oil-burning gas-turbine peaking plant at Princetown, England. Gas turbine is modified Proteus aircraft turbine, geared to drive 1000-rpm, 50-cycle alternator

steam-turbine plant promises to increase thermal efficiency from 3 to 5 per cent above that of a comparable steam plant. Furthermore, Sybert of Kaiser Engineers, and others, cite further advantages of installing a gas turbine for peaking at the optimum time: first, the benefit of the building block concept, deferring steam units; second, better acceptance of the combined cycle station, Ref 15.

Fuel for Gas Turbines

Ideal fuel for the gas turbine, of course, is gas and many of the present gas turbines are designed to burn it exclusively or alternately with distillate or diesel oil. For residual fuel oil, the work of Buckland and others in developing treatments for vanadium and sodium in the oil is well known. But for peaking operation, most gas turbines use lighter oil. When the gas turbine learns to burn coal, as it may at the Muskingum Station, the fuel situation will be interesting, to say the least.

In Europe, a number of free-piston machines used as gasifiers for gas turbines are installed in gas-turbine peaking plants, Ref 38, but so far none is in use in this country. Use of aviation types of gas-turbines has not been common, but the unit shown in Fig. 4 is a straight Proteus airplane turbine which was installed in England.

Gas Turbines Can Be Quiet

Important factor in gas turbine installation is noise prevention. Stephens points out that many engineers receive a false impression of gas turbine noise by witnessing the units on test in the manufacturer's shop where no attempt is made to suppress noise. Like the diesel engine, the peaking gas turbine may often be installed at a suitable load center on a power system that may be near a residential district. Both types can be rendered remarkably quiet.

For example, at the Williston gas turbine station, intake and exhaust silencers were so effective that observers directly across the street from it could scarcely hear the station sound unless they were down-wind. At the Caracas installation, Ref 39, best location for the plant on the transmission system was in the main part of a rapidly-developing residential district. Before silencers were installed, noise level 500 ft in front of the air intake chambers was 120 decibels. After the silencers were installed, it was only 70 decibels 10 ft from the intake filters.

New Development

Just announced by Westinghouse at press time is an Econo-Pac packaged gas-turbine plant, for automatic self-contained operation on peak load, housed in a sound-proofed, weather-proof housing, to be shipped as a unit and installed outdoors, as shown on page 67. It will be supplied in capacities of 3000, 7000, and 12,000 kw.

Remote and automatic control of peaking gas turbines can be readily designed, but details of it are outside the scope of this article. It will be discussed further in a future issue of POWER ENGINEERING. THE END

Fig. 5. Exterior view of new remotely-controlled Princetown gas turbine peaking plant, adequately silenced to meet residential requirements; at left, silencer in stack; at right, 12,000-gal fuel oil tank

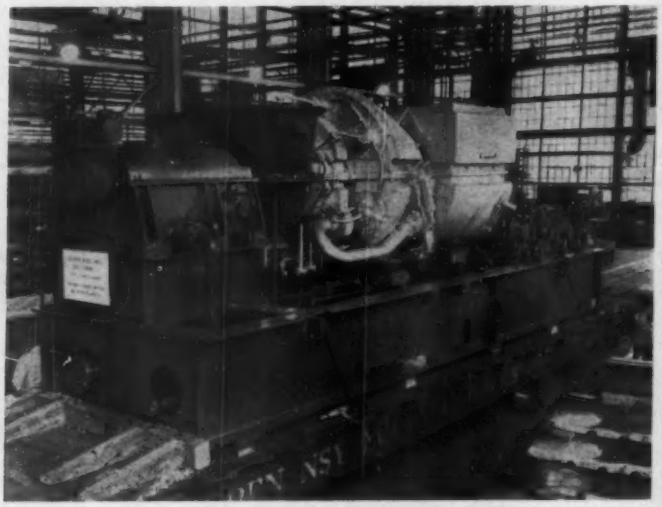


Fig. 6. This 5500-kw Westinghouse peaking gas turbine, scheduled for fall 1960 operation, will be installed in municipal steam plant at Austin, Minn., to combine later with steam turbine

Richard D. Harza, registered professional engineer; Northwestern Univ. 1944, Master's degree 1947; U. S. Navy Ensign 1945–1946; associate member ASCE; vice president and new-business manager of his company.* Since 1947 he has had experience in design and construction of dams and power plants, irrigation and reclamation works in U. S. and many foreign countries.

Fig. 1. Priest Rapids 800-Mw hydro plant on Columbia River, designed to operate at 37.5 % capacity factor at low flow

HYDRO AND PUMPED STORAGE FOR PEAKING

RICHARD D. HARZA OF HARZA ENGINEERING CO SHOWS HOW THEY FIT; PUMPED STORAGE HERE AND ABROAD, MORE PLANNED FOR U. S. A.

THE PROBLEM of providing economical daily peaking capacity for electric power systems has recently been the cause of much serious thinking and extensive discussion with the power industry. Statistics show that the average system load factor in the United States is about 60 per cent. In the past, this problem almost seemed to solve itself in the form of two important operating rules: first, to the extent available, use system hydro capacity to meet daily peak demands; second, use older and less-efficient thermal units for the peak service. In many systems today, both the foregoing peaking sources are fully utilized; therefore advance system planning is looking with great diligence for different, economical peaking sources.

Modern utility system practice in most parts of the country now calls for putting hydro capacity "on peak," with the thermal units of the system being assigned the base load foundation. This practice becomes more accentuated during the periods of low water availability. Examples can be cited from Pennsylvania to California, and from as far away as the Philippines and West Pakistan. Figure 2 illustrates this modern practice. In California, hydro units are being designed for operation at a 35 per cent load factor, and even lower load factors are in prospect.

Some of the nation's largest hydro powerplants are now in peaking service. Large blocks of Hoover Dam power are used in the Southern California and Los Angeles systems at very low load factors. The new 800-Mw hydro plant at Priest Rapids on the Columbia River, Fig. 1, was designed by us to operate at a capacity factor of 37.5 per cent during the low flow season, and its upstream sister plant now being constructed at Wanapum will operate at the same capacity factor. It is contemplated that the 800-Mw Wanapum plant will be completely shut down during off-peak hours in the low flow season.

Another example of this type of operation is the 20-Mw Petenwell Plant on the Wisconsin River. During low flow periods this plant runs only 10 hours per day on peak load service and is completely shut down for the remaining 14 hours. Naturally, during periods of high flow it goes into base load 24-hour operation to provide fuel savings to the predominantly thermal powered system to which it is connected.

From this it can be seen that where it is available, hydro power usually dominates the picture in meeting daily load peaks.

While it is not a new development, pumped storage of electrical energy is one of the methods receiving much attention today as a possible solution to the peaking problem. Unique feature of pumped storage is that, unlike other system power sources, it is not a "prime mover" but rather an

* Editor's Note: The September 1931 issue of Power Plant Engineering, now POWER ENGINEERING, contained an article on pumped storage by Mr. Harza's father, the late L. F. Harza.

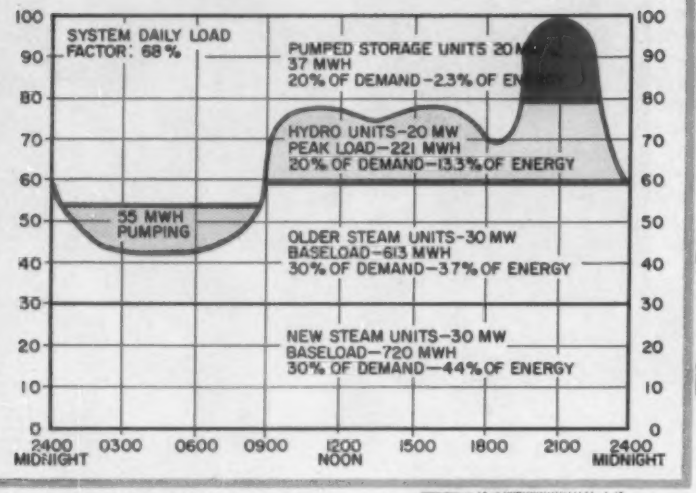
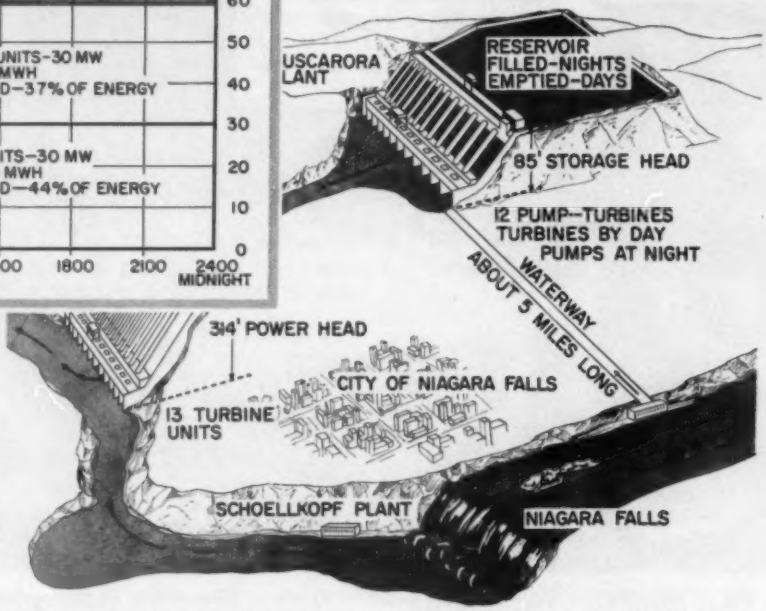


Fig. 2. (Left). Typical daily load curve of hydro-thermal system, showing portions of load to be carried by conventional hydro; pumped storage for peak, steam on base

Fig. 3. Artist's conception of Niagara-Tuscarora pumped-storage plant; it will contain 12 reversible pump-turbine units each rated 28,000 hp as turbines; operation 1961



"energy accumulator." Perhaps "system storage battery" is more descriptive of the pure form of pumped storage considered here.

In its simplest form, pumped storage involves the pumping of water during low demand hours to an elevated reservoir, using very low-cost, off-peak power from the conventional generating elements of the system, and then emptying this reservoir through a hydroelectric plant during heavy demand hours and thus obtaining additional system peaking capacity. Because it is not itself a prime mover, and since each of its elements operates at something less than 100 per cent efficiency, about one kilowatt-hour out of every three pouring through a pumped storage cycle is "lost." Theoretically, a pure pumped-storage plant has a "negative" load factor. Fortunately for the pumped-storage concept, however, this loss can be more than offset by the differential between the value of off-peak and on-peak energy and by savings in the unit investment cost of capacity.

The first U. S. pumped storage installation was at Rocky River, Connecticut, in 1928. During the 1920's, considerable pumped storage capacity was constructed in Europe, much of this being in high-head installations. In recent years, large installations have continued in Europe and have been undertaken on an important scale in No. and So. America.

Present total pumped storage capacity in the U. S. A. built or under construction is 851,500 kw (turbine rating), as shown in the table. European progress in pumped storage includes the following large plants: Lunersee, Austria, 270 Mw; Ffestiniog, Wales, 300 Mw (1962); Loch Awe, Scotland, 400 Mw (1963), and Vianden, Luxembourg, 800 Mw (1963–64).

Table of pumped-storage plants installed and projected in 1960 in United States

Completion Date	Plant Name	Rated Turbine Capacity-kw	Rated Turbine Head-ft	Purpose: D-Daily Peaking S-Seasonal Firming
1928	Rocky River, Conn.	24,600	200±	—
1950	Buchanan, Texas	7,400	100±	S
1954	Flatiron, Colorado	9,000	290	S&D
1956	Hiwassee, N. Carolina	59,500	190	S
1960	Tuscarora, New York	250,000	75	D
1962	Smith Mountain, Va.	143,000	195	D
1962	Taum Sauk, Missouri	358,000	745	D

Equipment for pumped storage has evolved through three stages. The original plants completely separated the motor pump units from the turbine generator. Next came the reversible motor-generator machine connected to both pump and turbine with suitable engagable couplings. Feasibility of this equipment depends on hydraulic operating speeds of the heads involved.

Recently the completely reversible units, consisting of one reversible motor-generator unit permanently coupled to one reversible pump-turbine, have become popular. This unit has been subject to the head range of the Kaplan and the Francis types of hydraulic turbines, which, for this purpose, extends to about 1000 ft of hydrostatic head. It is understood that a Swiss manufacturer of large-capacity high-head pumps is currently testing multi-stage pumps running in reverse as turbines and has achieved very encouraging results. It should be mentioned here that one of the great benefits of pumped storage as system peaking capacity is the characteristic of hydroelectric machinery, which permits loads to be accepted very quickly and smoothly. Unit sizes range from a few hundred kva capacity to the 179-Mw units — a world record — to be installed at Taum Sauk.

It is in order at this point to describe three modern pumped-storage installations in this country. At Niagara Falls, New York, a treaty regarding the diversion of water during daytime hours from the scenic Falls has inspired both the Canadian and the American power developments to incorporate large pumped-storage features, so as to be able to meet daytime and evening peak demands. The American development is shown schematically in Fig. 3.

It consists of a 60,000-acre-foot reservoir on flat table land surrounded with an embankment, and connected to the main Lewiston Plant

headrace through the Tuscarora pump-generator plant containing 12 reversible units each rated at 28,000 hp as turbines under 75-ft head. The reservoir will be filled each night by pumping and emptied each weekday to achieve peak generating capacity. Operation is scheduled to start in 1961.

In the midwest region, the $50,000,000 Taum Sauk pumped-storage plant is being built near Lesterville, Missouri, to provide 350 Mw daytime peak capacity for the St. Louis area. In this case, the upper reservoir covers 50 acres on a hilltop, and is completely surrounded by embankment. It feeds the fully reversible pump-turbines almost 1000 ft lower through a power tunnel in rock. The lower reservoir is a 370-acre reservoir on the small Taum Sauk Creek. The same water is re-used each day. The two vertical, Francis-type reversible units, rated at 179 Mw each as turbines under 745-ft head, will be the world's largest when they start operation in 1962.

Economics of Pumped Storage

Scope of this article permits only a brief discussion of the economics of pumped-storage schemes. As in all important power schemes, a great many factors must be considered, and for each individual scheme, it is likely that a different combination of the factors will dominate. Speaking very generally, it can be said that cost advantages lie in the direction of fully-reversible machines, high heads, and large units. Location and transmission are of key importance and the pumped-storage plant must be near the load center. Otherwise, an expensive situation involving transmission facilities used only a few hours each day will result.

It can be seen that location and topography are very important considerations in any pumped storage scheme. The reservoir requirement of pumped storage planning is perhaps more easily solved than would be expected. A pure pumped-storage plant is in part a hydroelectric plant that only operates a few hours a day. The same water is re-used day after day and "make-up water" requirements are small. As a result, extremely small reservoirs of only a few thousand acre-feet capacity may serve the needs of a 200 or 300-Mw pumped-storage plant. The reservoir does not need to be on a main stream; therefore spillway requirements become almost nil.

Savings in plant investment are of great importance so as to be able to offset the extra system cost of fuel consumed by the pumping cycle. In many pumped-storage schemes, the greatest cost items are the machinery and the water conductors or penstocks. Because of this, sites become more attractive economically as the upper and lower reservoirs are in closer proximity, with the resulting savings in penstock cost.

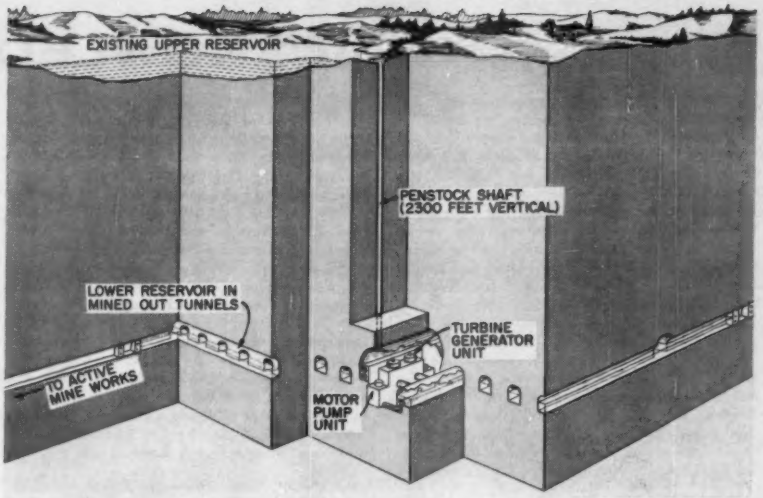

EXISTING UPPER RESERVOIR
PENSTOCK SHAFT (2300 FEET VERTICAL)
LOWER RESERVOIR IN MINED OUT TUNNELS
TO ACTIVE MINE WORKS
TURBINE GENERATOR UNIT
MOTOR PUMP UNIT

Fig. 4. Proposed pumped-storage plant will use abandoned mine as lower reservoir

Information on per-kilowatt costs of pumped-storage schemes is not abundant, but several midwestern utility companies consider that a pure pumped-storage plant becomes economically interesting when the cost is in the $140–160-per-kw range. Special topographic situations may exist where the cost would approach $100 per kw; while, at Niagara Falls, an estimated cost of $250 per kw still did not rule out pumped storage.

Any discussion of pumped storage should take note of the fact that although the simple "pure pumped-storage" scheme is usually the case of most interest for daily peaking service, a number of mixed pumped-storage schemes have been built. A number of tidal power schemes involve pumped storage as part of the cycle of operations. And in connection with large irrigation and water transfer schemes, it is proposed to pump water up one side of a mountain and then drop it down the other side through a series of reservoirs at hydroelectric plants, and this, in effect, can be used for daily peaking purposes.

Of course, the scenic restrictions on how much water may be diverted from Niagara Falls during daylight hours forms the basis for the two large pumped-storage plants at Niagara. Pumped-storage plants have been proposed along the Mississippi River that would pump water from just above a navigation dam into an off-channel storage reservoir, and later release this water through turbines discharging downstream of the navigation dam, thus incorporating an existing hydroelectric potential head into a new pumped-storage peaking plant.

Pumped Storage In a Mine

One of the more unconventional schemes which has been studied involves an underground pump-turbine plant connecting to a disused limestone mine as a lower reservoir. The upper reservoir, as shown in Fig. 4, is an existing process water pond 2300 ft directly above the mine. This scheme results in the shortest possible penstock (a simple vertical shaft) which will develop the given head, and permits development of a high-head pumped-storage scheme in quite flat country. Additional positive factor is that this source is located within a few miles of the load center of gravity of a large electric utility system.

There are seven pumped-storage plants now operating or under construction in the United States. This will represent about ½ of 1 per cent of total national capacity, and most of this pumped-storage capacity is employed for meeting daily peaks. In Europe, the figure is somewhat higher, being about 3 per cent. It is felt that, in the near future, the low-capital-cost pumped-storage peaking plants will progressively become more attractive as supplements to new high-cost, high-efficiency thermal and nuclear system base-load plants. Many utility engineers and their counterpart consulting engineers are busy today dusting off old maps and plans and revising their conventional hydroelectrical planning, to take full account of the great capabilities of pumped storage for meeting daily peak loads. THE END

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FOR REPRINTS OF THIS SECTION WRITE THE EDITOR, POWER ENGINEERING, 308 E. JAMES ST, BARRINGTON, ILL.

COMPUTER CONTROL FOR POWER PLANTS

R. A. BAKER, CHIEF OF THE ELECTRICAL ENGINEERING DEPT.,

ADDS UP THE SCORE FOR THE NEW AUTOMATION

PUBLIC SERVICE Electric & Gas Co formed a task force consisting of engineers from various departments to study the application of computers to power plants. As a result of our study during the past few months, we picture a type of computer control which has these characteristics: automatic start-up, optimum operation, performs equipment efficiency tests, prepares operating records, provides better equipment protection, automatic shutdown, independent instrumentation for manual operation.

In our present stations, we have some 50 control circuits associated with the boiler, some 30 circuits with the turbine generator, and roughly 100 control circuits installed on auxiliary equipment. Some of these loops are self-contained and have no supervision other than an alarm in the central control room; others can be adjusted by the operator.

We do not propose to eliminate any of these conventional controls at this time. Our present plans are to superimpose the computer on our existing control system.

We believe a digital computer is the best choice for power plant automation because the digital computer has significant advantages over other devices in terms of reliability, accuracy, flexibility, simplicity, and cost.

For the 342-Mw unit under study, we estimate a total installed cost for automation of $850,000, which is judged to be a reasonable percentage of the total estimated instrumentation and control costs for a unit of this size. Table I itemizes our cost estimates. We have itemized estimated savings in Table II.

Three years ago, we experienced major damage to a turbine unit when the main bearings failed to receive lubrication. Cost of the outage was about $1,000,000, and we think that the kind of repetitive checking that a computer can make would have averted this.

More recently, we had a furnace explosion which will cost approximately $4,000,000. Rapid sensing and fast computer action probably would have avoided the catastrophe.

Still in all, we are not claiming that the computer will avert all disasters, although its inherent ability to keep looking for trouble makes it seem as though it should. We have made our estimate on the basis of averting only one-half of the catastrophes; this has a capitalized value of $250,000.

To be conservative on fuel costs, we have taken credit for only ¾ of 1 per cent savings on the unit. In addition, we believe there is an additional system saving of $20,000 due to dispatching load with more accurate and up-to-date information.

On reduced outage time, here again, to keep on the conservative side, we have included only one weekday per year saving.

On personnel, we have eliminated only one shift position, at an annual cost of $24,000, or a capitalized value of $200,000. We anticipate eliminating two day-shift men in the Performance Department doing routine calculation. An additional capitalized savings of $60,000 can be realized by eliminating the conventional acceptance test, laboratory tests, and smaller routine performance tests.

Unfortunately, there are still some items on which we can't put a dollar and cents value, even though they are bona fide savings. For example, the computer will reduce maintenance costs by detecting equipment failures via rate of change readings.

Another example is in the form of deferred savings. If the computer performs as we anticipate, we can materially reduce instrumentation on future units.

Savings of $1,215,000 plus some additional indeterminate amount are indicated with an additional outlay of $755,000. This gives a net capitalized savings of at least $460,000 through this next step of automated station operation. THE END

This article is based on a paper presented at the Instrument Society of America's Power Instrumentation Symposium, 1960

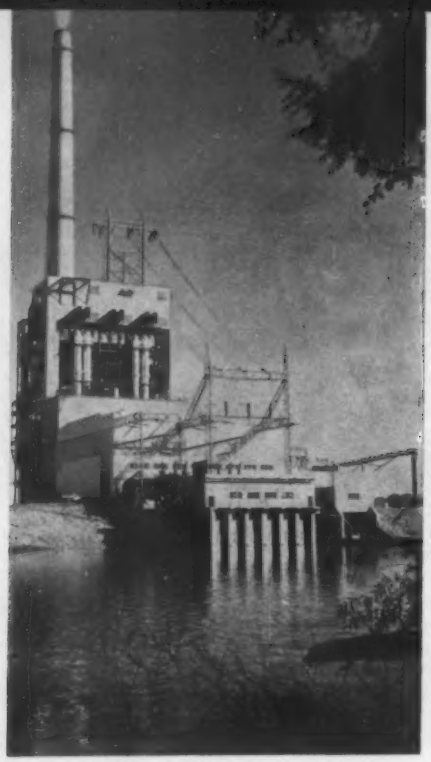
Table 1—Estimated Cost of Automation 342-Mw Unit

Computer and associated equipment		$ 560,000
Installation labor		125,000
Total direct costs		$ 685,000
Field overheads		45,000
Engineering and design		75,000
Contingency		45,000
Total installed costs		$ 850,000
Computer eliminates need for:		
Data logger	$ 90,000	
Automatic dispatch console	5,000	
		95,000
Total additional funds required for computer		$ 755,000

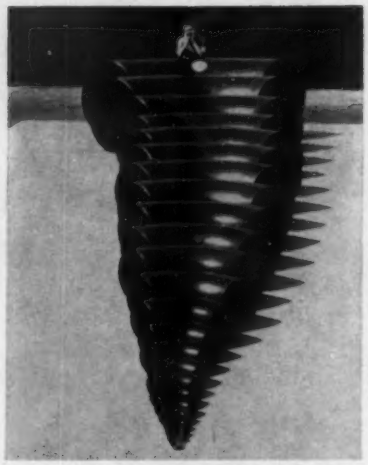
Table 2—Capitalized Savings of Automation 342-Mw Unit

Reduced possibility of catastrophic damage		$ 250,000
Fuel costs can be minimized		470,000
Unit	$450,000	
System	20,000	
Outage time can be reduced		100,000
Fewer personnel will be required		395,000
Operating	200,000	
Performance	135,000	
Testing	60,000	
Total calculated savings		$1,215,000

Plus factors
1. Reduced maintenance
2. Reduced instrumentation on future units



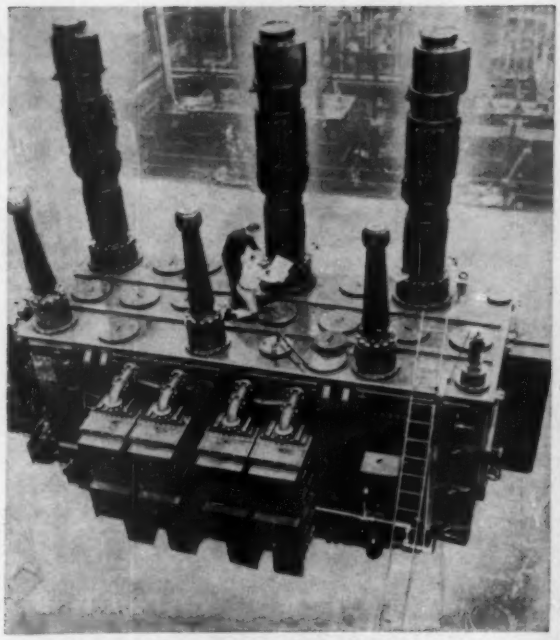
On the banks of the Wabash stands the world's largest electric power generating unit. It's 475,000-kw Unit 1 at Breed Plant in Sullivan County, Ind., part of American Electric Power



Pipe those elbows! This line-up of 25 forged steel elbows ranges from ½-in. to 42-in. sizes for industrial piping and pipeline systems. Display was by Tube Turns Div of Chemetron Corp

Power Engineering's

Portable clean-room controls airborne contamination for welding operations on heat exchanger equipment at American-Standard. Room has polyethylene top, expands in 6-ft lengths. Fans draw in and discharge filtered air



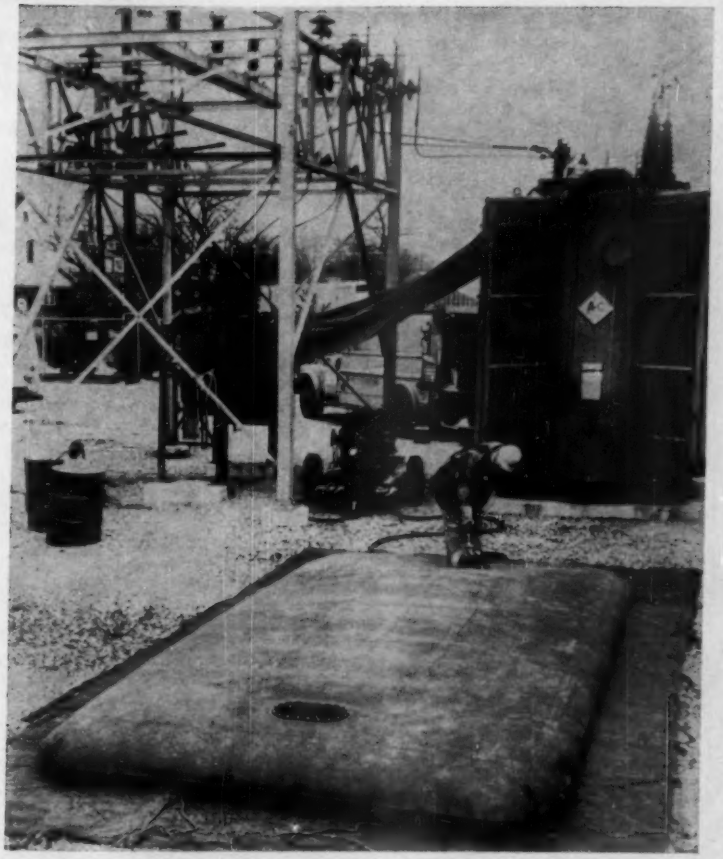
Largest transformers ever built by GE with bushing-mounted load tap changers are rated 300,000 kva, 230- to 138-kv. Use of these mechanisms eliminates the need for series transformer

Park St Pumping Station, Syracuse, N. Y., uses two Westinghouse 125-hp Rectiflow drives for a total of 4½ million gallons of water a day

Dangling 34 stories up, 12½-ton air-conditioning unit hung this way for 8 hours while emergency repairs were made in boom. Blazer unit was on way to the top of 140 West St, N. Y. C.

NEWS REEL

Snap-on installation for lightning shielding failure indicators made by GE for use by Ohio Power Co at Lima. Device is means for studying cause of flashover, effectiveness of shielding



Pillow tanks by Goodyear are designed to save man-hours in maintenance of oil-bearing transformers and circuit-breakers. Oil from units is stored in big pillow instead of drums

CARBON STEEL PIPE SELECTION

DESIGN EXPERT EARLE SOMMERFIELD, OF UNITED

				POWER PIPING CODE		BOILER CODE	
ASTM	Method of Manufacture	Grade		Temp. Limit F	All. Stress at Temp. Limit	Temp. Limit F	All. Stress at Temp. Limit
A120	Seamless (4)	—		450	9,600		Not Approved
	Lap welded (3)	—		450	7,600		Not Approved
	Butt welded	—		450	5,700		Not Approved
A53	Seamless (6)	A		900	10,700 (@ 750 F)	800	10,700 (@ 750 F)
		B		900	12,950 (@ 750 F)	800	12,950 (@ 750 F)
	Electric res. welded	A		750	9,100	800	9,100 (@ 750 F)
		B		750	11,000	800	11,000 (@ 750 F)
	Lap welded (3)	—		650	9,000	650	9,000
	Butt welded	—		650	6,750	650	6,750
A106	Seamless (5)	A		900	10,700 (@ 750 F)	800	10,700 (@ 750 F)
		B		900	12,950 (@ 750 F)	800	12,950 (@ 750 F)
A134	Electric-fusion (arc) welded steel plate pipe (straight or spiral seam)	A245	A	650	8,800		Not Approved
			B	650	9,600		
			C	650	10,100		
		A283	A	650	8,300		
			B	650	9,200		
			C	650	10,100		
			D	650	10,100		
A135	Electric resistance welded		A	750	9,100	800	9,100
			B	750	10,100	800	11,000 (@ 750 F)
A139	Electric-fusion (arc) welded (straight or spiral seam)		A	750	8,300		Not Approved
			B	750	9,950		
A155	Electric-fusion welded (Class 2)	C45		850	8,700		Not Approved
		C50		850	9,900		
		C55		850	10,850		
		KC55		850	10,850		
		KC60		850	11,650		
		KC65		850	12,450		
		KC70		850	13,250 (all @ 750 F)		

CHART FOR POWER PIPING

ENGINEERS, SIMPLIFIES A TEDIOUS ENGINEERING JOB

Available (1) Weights	Available Sizes	Available Lengths: Standard Random	Available Lengths: Double (2) Random	Limitations
See Note (4)		See Note (4)		**Do Not Use:** (a) For steam above 125 psi or 450 F (b) For water above 175 psi (c) For water with screwed connections above 100 psi if temp. is above 220 F (d) For Boiler Code application (e) For close coiling or bending
See Note (3)		See Note (3)		
Sch. 40 & 80	⅛″ through 4″	16 to 22 ft	Min Avg 35 ft	
Sch. 10	14″ through 24″	Std weight random lengths, 16 to 22 ft; XS and XXS, 12 to 22 ft	Std weight or XS, min avg length, 35 ft; range 32 to 44 ft XXS subject to inquiry	**Do Not Use:** (a) For temps above 750 F (b) For steam above 600 psi (c) Electric resistance welded for water systems with screwed connections above 100 psi if temp is above 220 F, nor for threaded steam systems above 250 psi (d) Grade B for close coiling, cold bending and forge welding
Sch. 40, 80, Std + XS	⅛″ through 24″			
Sch. 120	4″ through 24″			
Sch. 160	½″ through 24″			
XXS	½″ through 8″			
All other sch.	8″ through 24″			
Std + XS ½″ wall & lighter	5″ through 12″	16 to 22 ft	Min Avg length, 35 ft	
	14″ and 16″	16 to 22 ft		
See Note (3)		See Note (3)		**Do Not Use:** (a) For temps above 650 F (b) For steam above 250 psi (c) For water above 400 psi (d) For threaded water systems above 100 psi if temp. is above 220 F (e) Butt welded for flanging
Sch. 40 & 80	⅛″ through 4″	16 to 22 ft	Min Avg 35 ft	
	Same as A53 Seamless			**Do Not Use:** (a) For temps above 750 F (b) Grade B for close coiling, cold bending and forge welding
	Same as A53 Seamless			
Up to ¾″ wall thickness (Standard plate thickness)	16″ & over	Average 29′ with 20′ Min.	—	**Do Not Use:** (a) For temps above 650 F (b) For steam above 250 psi (c) For water above 400 psi (d) For Boiler Code application
¼″ through ¾″	20″ to 40″	Average 38′ with 20′ Min.	—	**Do Not Use:** (a) For temps above 750 F (b) Grade B for flanging or bending
Up to ⅜″ wall thickness	18″ & over	Average 29′ with 20′ Min.	—	**Do Not Use:** (a) For temps above 750 F (b) For Boiler Code application
As required (Standard plate thicknesses)	16″ & over	As agreed upon with Manufacturer		**Do Not Use:** (a) For temps above 750 F (b) For Boiler Code application

NOTE (1) Standard weight weld fittings are same wall thickness as Sch. 40 through 10″, then ⅜″ wall; XS are same as Sch 80 through 8″, then ½″ wall. (2) Double length not normally available in jobber stock. (3) No longer manufactured. Use A53, seamless or electric resistance weld. (4) Not normally available or used, since A53 seamless is usually equal in price. (5) Grade C also available (70,000 lb/sq in. Tensile). (6) API 5L is acceptable equal.

1
2

WHAT OIL-BURNING SYSTEM FOR THE AUTOMATIC PACKAGED BOILER?—2

HERE IS THE CONSENSUS OF SEVERAL PACKAGED BOILER MANUFACTURERS ON WHAT TYPE OF BURNER TO USE

AFTER publication of the article What Oil Burning System for the Automatic Packaged Boiler? in the April issue of POWER ENGINEERING, many readers and several boiler manufacturers took issue with its author, Patrick D. Goggin, on several of his comments. It appeared that boiler manufacturers differ greatly in their opinions on burner applications. To clarify the issues and present fairly all sides of the question, a survey was conducted among manufacturers of this type of boiler. This is the result of that survey.

Rotary Cup Burners

Users of this type of burner showed greatest displeasure at Mr. Goggin's discussion. General interpretation of his article was that the rotary cup burner is least applicable to automatic firetube boilers of the Scotch Marine type. Most comments, therefore, referred to this burner.

The rotary cup burner is a form of air atomizing burner which employs a rotating cup to spread a thin film of oil from the leading edge. When this film is thrown off the edge at high velocity, the oil is broken up into small droplets and distributed in the primary air stream. Primary air is supplied by a blower, integral with the burner, which directs an air stream through a nozzle, and around the periphery of the cup, in such a way as to complete atomization of the oil droplets. An advantage of this type burner is that the mean droplet size produced by the cup is a function of speed of rotation only, and is relatively independent of the rate of fuel supply.

Flame shaping is accomplished in two ways: by the shape of the rotary cup, and by the air nozzle which directs the stream of air around the periphery of the cup. Considerable versatility is thus available, and the burner can be designed to give good results in practically any furnace.

One manufacturer of rotary cup burners makes some illuminating comments which may explain the background for Mr. Goggin's analysis:

When packaged boilers with Scotch-type furnace of reduced diameter were introduced, some boiler manufacturers had difficulty with the rotary burner because sufficient radial clearance around the nozzle was not provided. A larger furnace diameter is more suitable for this type of burner. The greater diameter (with increased combustion volume) has its advantages: quieter operation, lower temperature of gases entering the boiler tubes, and less thermal shock to the heat transfer surface. Many such units are in operation enjoying the advantages of the rotary burner with properly-designed furnace: lower electric power requirements, low oil temperature and pressure, generally simplified and fewer components, and less maintenance.

Another boiler manufacturer, who uses both rotary cup and pressure atomizing burners, offers the following comments:

We do not believe that good rotary cup burners are relatively inexpensive. We do believe that the choice of oil burner should not be based principally on first cost. The design engineer should select the burner which will be the best value in terms of performance, when installed in the intended application, for use with the *hardest to burn* fuel which may be encountered.

The rotary cup burner does not require a bigger blast of secondary air than is required by the pressure atomizing type. Both have the same total air requirements and neither introduces air with the fuel. The means to shape the flame differ, but a skillful and experienced rotary burner serviceman can accomplish a wider variation by the various adjustments than can be accomplished by changing nozzles and other things in a mechanical atomizing system. Both types are sensitive to viscosity, which in turn makes them sensitive to oil temperature changes. We do not see any important advantage of either in this detail.

Turndown ratio is limited more by the air system than by flexibility of the nozzle. This problem would be common to all burner types. It is difficult to expect burner performance to remain optimum when atomized oil velocity remains high, while air velocity is reduced to a low value. However, as one boiler manufacturer emphasizes, a turndown ratio greater than three to one is seldom necessary or desirable on this type of boiler.

Rotary burners basically are of an old design, with operation and mechanisms well proved over the years. Though great improvements have been made recently to better adapt the burner to today's high-viscosity fuels, the basic design is a familiar one. **Availability of qualified local service people may have a material effect on the type of burning equipment which is selected for the smaller installation. There are probably more servicemen familiar**

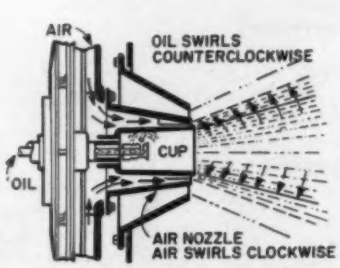


Fig. 1. Typical rotary cup oil burner

with rotary cup burners than with other types, and there will not likely be a major change in this situation for some time.

Air Atomizing Burners

A manufacturer of both rotary cup and air atomizing burners expresses preference for the air atomizing type:

We feel that this burner gives us better control over the combustion of a wide range of fuels, better atomization of this fuel, and the ability to burn the fuel in smaller diameter furnaces.

Perhaps one of the principal sources of maintenance is the air compressor. However, manufacturers of boilers and of compressors have been and are working closely together to further reduce this service and maintenance problem.

Another boiler manufacturer who employs both rotary cup and air atomizing burners also expresses a preference for the air atomizing type, but definitely denies having any trouble with compressors. He also mentions that it is not necessarily true that the compressor must be located relatively inaccessibly.

Having had experience with rotary cup burners, and a limited amount with mechanical atomizing type, and having done a great amount of development work on air atomizing, **we concluded that the air atomizing burner is the most versatile for the market presently being reached by the packaged boiler of the Scotch marine type. It may have some minor theoretical disadvantages, but it is not as critical to variations in grade of fuel, to viscosity due to heating, or to coking on shutdown. The criteria of reliable performance and highest efficiency with minimum maintenance are more easily met with the air atomizing burner than with any other type.**

With heavy oil, the burner nozzle and piping are purged of oil; heated oil can flow quickly for the next start-up cycle. This eliminates coking of oil in nozzle and congealing of oil in piping.

Steam atomization has little applicability to packaged firetube boilers which are predominantly low-pressure. One manufacturer expresses a definite preference for the steam atomizing burner as the best type for a boiler; but he agrees that it requires more attention than most small plants will give it. On this basis, he claims it is a very poor burner to use. He also states that high-pressure mechanical and steam atomizing burners have been found to be ill-suited to automatic unattended firing; and steam atomizing burners cannot be used reliably with steam pressures below 100 psig.

With regard to steam consumption of this type burner, the remarks of Mr. Goggin seem to have been misinterpreted by those who commented on this point. It is of course absurd to imply that 10 per cent of the boiler output would be required for atomization. The article mentioned this figure only as a maximum value which could be approached in case a burner used steam or air interchangeably. The implication was that efficiency of design was sacrificed in order to reduce the air-pressure requirement for start-up. Whether or not this was a valid point to make is open to argument. In any case, the article also stated that the average steam consumption of a well-designed burner should fall between one to three per cent of boiler output. According to generally available references, modern steam atomizing burners do not usually require more than two per cent of generated steam for atomization.

Mechanical Pressure Burners

A manufacturer explains his preference for mechanical atomization as follows: **It does not depend on steam (quick and independent start-up), or on auxiliary air (another system of controls, components and related costs). It can be brought up to high velocity combustion volume release rates, resulting in small unit size. It permits accurate rate control, flame pattern distribution, and flexibility in terms of speed of response (ignition, shutdown, etc). It is simple and readily suited to small units of a compact design.**

Higher pressures (up to 300 psig), and higher temperatures (up to 300 F for heavy oils), are required, resulting in somewhat costlier components; but this is offset by simplicity in achieving clean starts and stops. Steam or air atomizing burners would have less critical oil control problems for high turndown rates, but this advantage is limited by air system distribution and velocity control. They have the disadvantage of other system controls plus additional components.

A rotary cup burner manufacturer points out that high temperatures and pressures may cause carbon separation within the oil heater, with consequent necessity for more frequent cleaning. When burning residual fuels with their relatively high percentages of ash-containing abrasive materials, efficient operation may require frequent replacement of expensive nozzles. Also, a well designed nozzle is not so simple in its construction; many complicated passages make adequate cleaning a problem.

Summary

Like many other items in an integrated unit, there is no one best type of burner. Each burner is matched to the unit design to perform the burning function required. One manufacturer states: **I am certain that rotary burners or mechanical pressure atomizing burners cannot be used interchangeably with boilers designed for either type burner. Each type of burner can be, and is, used successfully by particular manufacturers. This has come about by the experimental work which each manufacturer has done to apply his choice of burner to his particular design of unit.**

Successful firing can be accomplished with a number of types of burners. Of prime importance is the requirement that the burner and boiler unit be matched for the particular operating conditions to be encountered. THE END

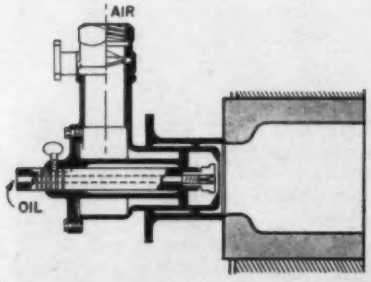


Fig. 2. Oil burner for air atomization

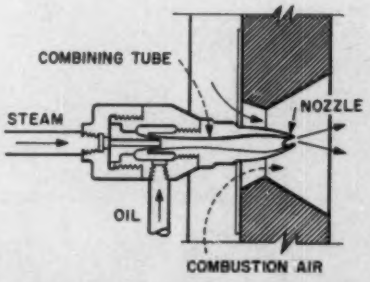


Fig. 3. Steam atomizing oil burner

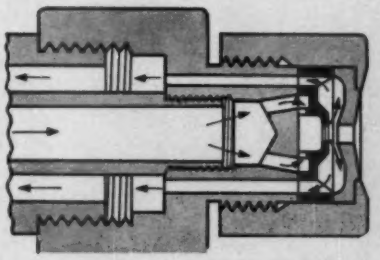


Fig. 4. Mechanical atomizing burner

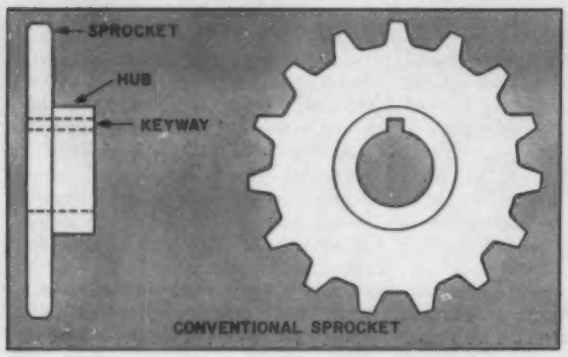


Fig. 1. Conventional chain-sprocket which sheared in log-jam

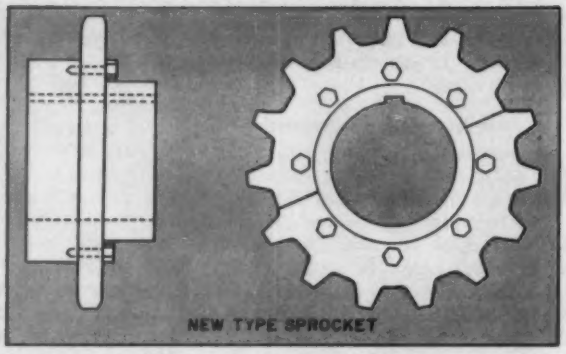


Fig. 2. Hub is stationary, sprocket may be removed if sheared

CLEVER DEVICE SOLVES HYDRO TRASH-RACK PROBLEM

LONG-TIME HEADACHE, IN CANADIAN HYDRO PLANTS, IS LICKED BY INGENIOUS SHEAR-SPROCKET AND LIMIT-SWITCH

A CENTRALIZED machine shop, in the vicinity of several hydro-electric stations, is a most worthwhile investment. While most outlying stations have a small lathe, drill press, hacksaw and forge, the main central shop is equipped with several large lathes. In addition, this shop has a planer, shaper, milling machine, horizontal boring mill, three drills, power hacksaw, "do-all" machine, hydraulic press, plus blacksmith and welding shops.

Such a shop pays dividends in making repairs and new parts for items within its capacity; however, such equipment as large runners and bearings (that require a large boring mill) have to be sent to an outside shop.

However, here's one on-the-job project which paid handsome dividends.

Equipment concerned was our self-cleaning trash-racks, the function of which is to remove from the turbine intakes the trash and water-soaked pulp wood that washes downstream, just under the surface of the water. On the river referred to, some 50 million logs pass the power houses each year on their way to the paper mills below. It is estimated that about 5 per cent of these logs become *deadheads*, many finding their way to the turbine intakes, where they become a menace to good operation. This is especially true during the spring run-off, when the high-water conditions wash down wood and debris that has become stranded.

Briefly, these racks consist of three

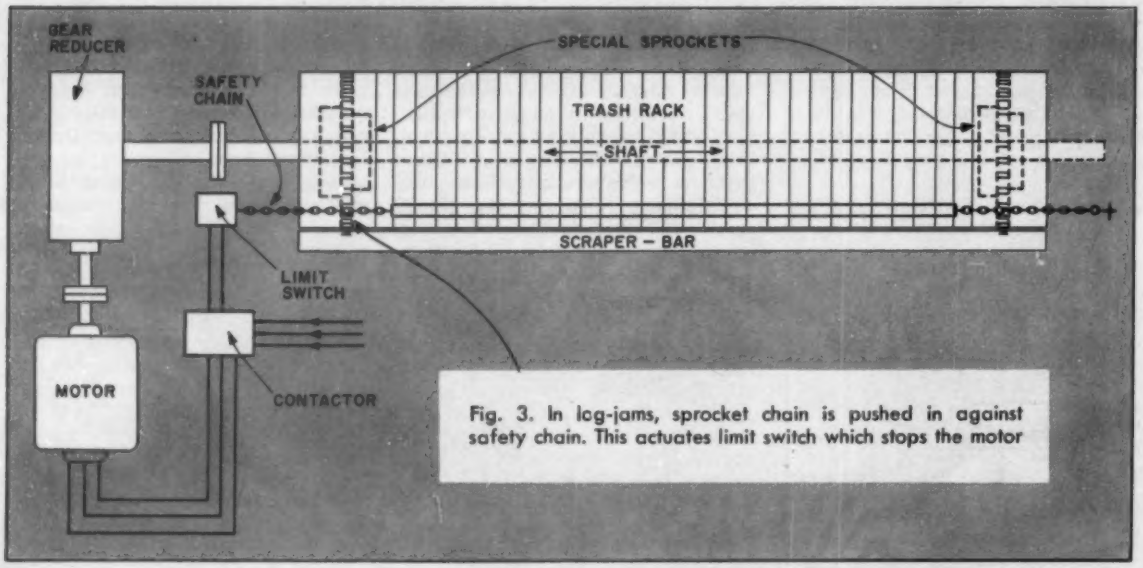


Fig. 3. In log-jams, sprocket chain is pushed in against safety chain. This actuates limit switch which stops the motor

slowly moving link chains, with special fittings to take the equally spaced 3-in. angle-iron scraper bars. (See photo.) It is these scraper bars that remove the undesirable *dead-heads* and other debris, consisting of washed out stumps, bark and tree branches. The motor is 7½ hp, with a speed-reducer having a ratio of 97 to 1, driving the chains at fpm.

Under normal river-flow conditions, little trouble is experienced, but during the spring (when the river flow jumps to six times normal), the racks are forced beyond their capacity. The result is that small-diameter wood works its way through the openings in the inclined rack bars and becomes stuck; then more wood finds its way under the chain, and shortly there is a jam.

What a Jam Can Do

It will be understood that the behavior of pulp wood, at such a time, can be quite freakish and unpredictable. Unless workmen are at hand to stop the rack, the jam can result in the stripping of the sprocket-teeth, broken chains and bent scraper bars. Our experience is that the motor-starter thermo relays do not trip quickly enough, to clear the circuit, and stop the motor.

In the past, the gear sprockets were made up as a solid unit from cast iron, machined undersize, then shrunk on, and keyed to the shaft. (Cast iron was used because it was felt that it was better for the sprockets to act as shear points, rather than other components of the rack.) When they wore out, or were broken, it was necessary to remove the shaft, take it to the shop, drill numerous holes, then split the faulty sprocket to get it off the shaft, before installing new sprockets.

This went on for over thirty years, and had become accepted as standard procedure. Then, one of the shop men suggested that we make use of the broken sprocket as a hub, to which could be attached double-duty sprockets of the split variety. These, of course, could be easily replaced in the field, should a failure occur.

Photographs show the equipment and type of sprocket used. The header-shaft, with its broken sprockets, was removed and set up in a lathe; then machined so as to form a hub to take the new split-sprockets. The eight holes were then drilled (and tapped) to take the high-tensile steel cap screws.

Although the change called for a reasonable amount of machine-shop work, it is certain that, in the future, the new arrangement will result in a considerable saving in time-consuming labor costs. THE END

Fig. 4. Close-up of sprocket chain, limit switch, and safety chain (which is aircraft cable inside length of ¾-in. pipe, and actuates power cut-off in jams)

Fig. 5. Motor, gear-reducer, trash-rack and chain-scraper assembly. Cut-out device was developed to prevent sprocket rupture, or make repairs simpler

Fig. 6. Log shown jammed into trash-rack. Note that wiper-bar has been forced into safety chain (connected to limit switch). This opens motor circuit, protects sprocket

Power Engineering HANDBOOK

How to Detect Oil in BF Water

By HAROLD R. ENGLUND, Chief Chemist, Water Analysis, Acme Chemical Co

OIL IN BOILER WATER and steam condensate is invariably present as a contaminant. As little as 7 ppm can cause priming and surging in high pressure boilers. Larger amounts of oil can burn on tubes to cause hot spots, which in turn can cause tube failure due to burn-out.

The following method has been used routinely in the writer's laboratory to detect traces of oil in boiler water and condensate samples. The method is a qualitative test which is especially useful when not enough sample is available to conduct a standard quantitative test for oil. This method depends on the natural fluorescence of petroleum products. When viewed under ultra-violet or "black light," petroleum products exhibit a characteristic fluorescence or glow. It is this property which enables us to use the ultra-violet lamp for the detection of oil.

Equipment consists of: 1. ultra-violet light source, Mineralite No. SL2537 or No. 3660. The No. 3660 gives the most brilliant fluorescent with petroleum products, but any other UV source such as a Cenco No. 71373 ultra-violet lamp can be used.

2. Infra-red drying lamp, GE Industrial lamp, controlled with Adjust-A-Volt Rheostat model 500 B.

3. Filter paper, Whateman's No. 1.

The boiler water or steam condensate sample should be at room temperature. Wash all glassware thoroughly to remove all traces of oil and grease from previous tests. Filter a 50-ml sample through the Whateman paper. Shake or stir sample during filtering to prevent loss of oil on walls of sample container.

Rinse sample container and wash filter paper with the distilled water. Dry filter paper under infra-red drying lamp. Support the filter on a bright reflective surface such as aluminum foil or, as used in our laboratory, a bright, one-gallon paint can lid. Control the infra-red lamp with the rheostat to prevent charring of the filter and distillation of any oil present.

After drying, examine the filter paper under the ultra-violet light. Examinations are easily made in an unilluminated hood. The presence of oil will be shown by the characteristic bluish or purple-blue fluorescence.

Oil present on the filter paper can be concentrated and its presence confirmed by eluting the filter paper with acetone, carbon tetrachloride, or petroleum ether. Catch the filtrate in a Petri dish in which a 9-cm piece of filter paper has been placed. Evaporate filtrate to near dryness. Dry filter and dish under the infra-red drying lamp and examine for oil under the ultra-violet light source. In this case, any oil present will be free from contamination and will give a strong blue or bluish-purple fluorescence. The filter paper sample can be retained for future reference.

The method is not affected by phosphates, caustic soda, soda ash, silicates, nitrates or other inorganic chemicals normally associated with water treatment. It was thought that some of the neutralizing amines used as steam line additives might cause interference. These compounds, such as morpholine, were found to volatilize under the drying lamp and did not result in any interference.

The method was capable of detecting less than 0.005 ml of oil per liter of water, which is less than 5 ppm.

The method was also effective in detecting paraffin oil, No. 2 and No. 6 fuel oil, mineral oil, mineral spirits, naphtha, olive oil, and coconut oil. Free or emulsified oil can also be detected by this method.

While the test is qualitative, it does detect oil contamination, and thus points out the need for corrective measures in boiler installations. The method is particularly useful where a new boiler is being purged to remove cutting oil and greases.

Reuse That Gasket!

By H. MULLER

WHEN OVERHAULING old plant equipments that carry gaskets, it sometimes happens that no replacement gasket is available, or is difficult to secure. In such cases, soak the asbestos gasket in hot water as soon as it is removed and cleaned. Soaking softens the asbestos in the gasket, and when it is replaced, allows tightening down as with a new gasket. The soaking also removes much of any oil that might have entered the gasket in use.

That Black Bottle

By NATHAN R. SMALL

WHAT WAS that mysterious black bottle those oldtime machinists had in their tool kit? It was black to resist sunlight, and it would loosen tight screws or bolts when all else failed. A few drops were applied and allowed to soak in for a few minutes.

Answer: just hydrogen peroxide.

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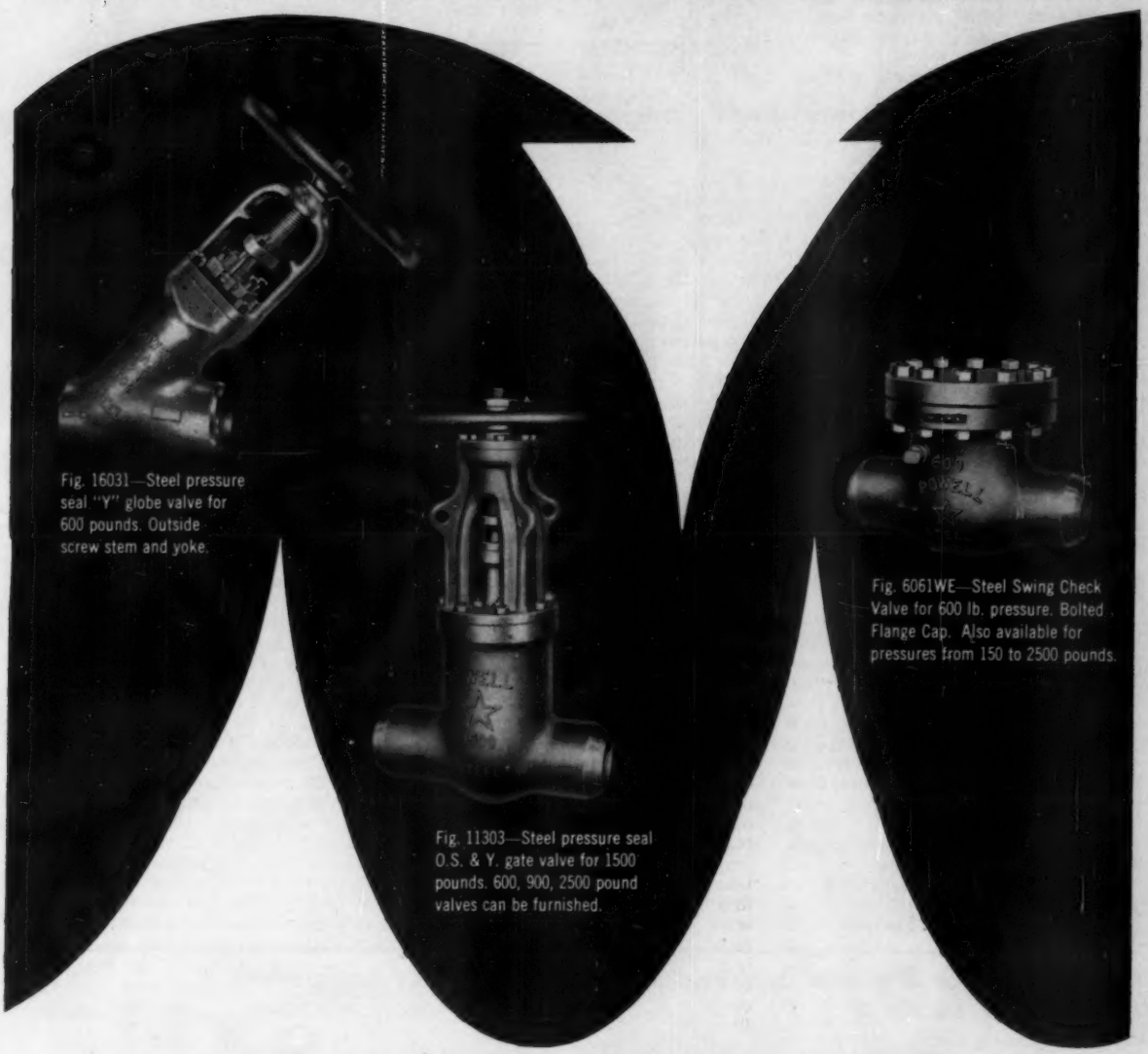

Fig. 16031—Steel pressure seal "Y" globe valve for 600 pounds. Outside screw stem and yoke.

Fig. 11303—Steel pressure seal O.S. & Y. gate valve for 1500 pounds. 600, 900, 2500 pound valves can be furnished.

Fig. 6061WE—Steel Swing Check Valve for 600 lb. pressure. Bolted Flange Cap. Also available for pressures from 150 to 2500 pounds.

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How Leaking Brine Tank Was Repaired

By C. T. BAKER, Consulting Engineer

BRINE TANK 15 ft wide by 16 ft long by 6 ft deep and fitted with two stands of double pipe brine coolers supplied refrigerating service to a group of small cold storage rooms. The tank had been in service many years. It was installed before tank sections were riveted, so was a hand-riveted job, using ½-in. by 1⅛-in. rivets.

Due to the temperatures carried in the tank (usually about 10 F) calcium chloride brine was used, to prevent the freezing of the double pipe brine coolers. The brine was maintained at a strength sufficient to resist freezing even at the low suction pressures that prevailed during occasional pump down periods.

Some months ago the presence of brine was noted on the concrete floor of the tank room. As conditions grew worse, it was decided to empty the tank and attempt to locate the leak or leaks.

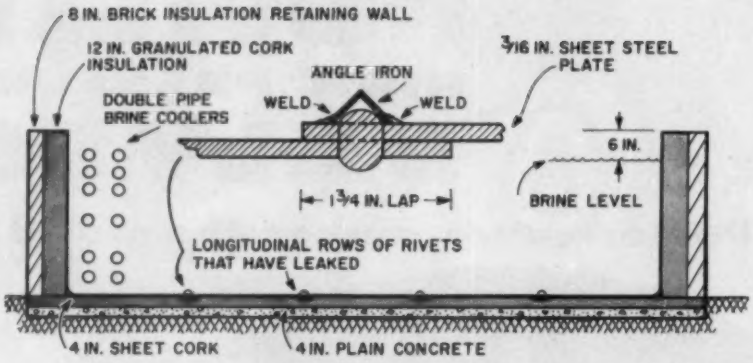
After the tank was emptied and thoroughly cleaned of a considerable accumulation of dirt and muck, several defective rivets were discovered in two of the rows of rivets, as indicated in the figure.

Before emptying the tank, the brine was tested and found to have a pH of 6.5, a decidedly acid condition. Because of this and the fact that the brine was very dirty, it was thrown out and new brine provided.

Repairs to the leaking riveted joints were made, as shown in the figure, by placing an inverted angle iron over the rivet heads. All riveted joints in the tank were treated in this manner so as not to overlook any leaks.

The welds were continuous on both sides, and the ends of the angles were closed by welding a plate at each end, which prevented brine from entering the space between the tank sheet and top of angle iron.

Brine coils in all storage rooms were found badly fouled with dirt from the original brine. Each coil was flushed with high-pressure clean water.



When the brine return bends of the double pipe brine coolers were removed following a thorough washing with clean water, it was discovered that the inner tubes were coated with a thin covering of deposit from the old brine. To remove this nonconductor of heat, it was necessary to hand scrape each individual tube and then re-wash with fresh water.

For some time prior to the repair operation, trouble had been experienced in maintaining desired temperatures in the refrigerated rooms. Some of this trouble was the result of dirt deposits in the room cooling coils and some the result of deposits in the double pipe brine coolers.

It had become difficult to regulate the hand expansion valves on the two brine coolers so as to prevent liquid carryover to the ammonia compressors. This difficulty largely disappeared following the house-cleaning operations.

No strainer had been placed on the suction line at the brine pump when the unit was installed; consequently, when the pump was opened for inspection, a very considerable quantity of muck was found in the casing, some of which had lodged in the end of the suction and discharge opening of the pump.

A pressure gage on the pump discharge had been damaged beyond repair. It was replaced with a new one. Twin strainers were installed on the pump suction and a compound gage graduated for both pressure and vacuum was installed between the pump casing and strainer to indicate when the strainer in service was becoming fouled.

When new brine was made, it was treated with cromates. A pH indicator was obtained, to be used at frequent intervals to keep check on the condition of the brine.

It was discovered that one of the causes of low pH of the original brine was the manner in which the brine from the several cooling coils was returned to the brine tank. The return from each room was connected to a common return line, the end of which was located several inches above the brine level in the tank.

In falling considerable distance between the end of the pipe and the brine level in the tank, the brine absorbed considerable air, in addition to setting up a siphon effect which induced air in considerable volume to be carried along with the column of falling brine into the tank. (Oxygen and Co_2, when mixed with brine solutions, soon produce an acid condition that can become most serious in its effect on metals.) End of the return pipe was partly enclosed by a section of a larger pipe to prevent splashing at the tank top.

Menace of the falling brine was removed by submerging the end of the return brine line several inches below the normal brine tank level.

Quick Way to Replace Bushings in Small-Diameter Equipment

By GORDON T. LENAHAN,

Peoples Gulf Coast Pipeline Co

OFTEN after a small bronze bushing has been pressed into place, it is necessary to remove a little metal from inside the bushing in order to make it fit the shaft properly. Of course, a reamer can be used for this but the proper size often is not available or hardly seems worth using to remove perhaps half-a-thousandth of bronze.

I have had excellent results from using a ¼-in. cotter pin 4 in. long to grip the end of a piece of 2-in. wide emery cloth which is then given a few wraps around the pin. The end of the pin is then chucked in a ¼-in. hand drill.

The metal comes off uniformly and surprisingly rapidly. Also, the end of the emery cloth being used will wear out at just about the right rate to present a fresh cutting surface for that job and the next.

Power Engineering HANDBOOK

Want minimum maintenance on a dual-fuel engine? —STANODIESEL Oil M

Stafford, Kansas Light Plant finds this lubricant helps hold down maintenance and operating expense

Bill Ray, (left), Standard Oil lubrication specialist calls on Stafford city superintendent LeRoy Priess. Rendering technical assistance to customers such as this is Bill's job. He is qualified for it through seven years' service with Standard Oil Company. Bill is a graduate of Wichita University.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

From February, 1953 to April, 1959 a 1,280 hp., 720 rpm., dual-fuel engine at the Stafford, Kansas Municipal Light Plant generated more than 12.5 million kilowatt hours in 29,780 hours of operation. At the end of this period the top piston rings were replaced; however, the amount of wear was almost too small to measure. Rings, pistons and cylinder walls showed only a negligible amount of carbon and varnish. Lube oil consumption was 7,399 gallons or 1,697 kw. hours per gallon.

You can get this kind of service with STANODIESEL Oil M. The oil's superior base stock, coupled with its additives gives you these maintenance and operating savings: low oil consumption, reduced port deposits, fewer stuck rings, less need for ring replacements, less cylinder wear, lower filtration costs and fewer bearing problems.

Learn more about STANODIESEL Oil M. Call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

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Piston after 29,780 hours. Virtually no carbon deposits or varnish are visible.

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Index to ASTM and Government Specifications for Industrial Insulations

By the National Insulation Manufacturers Association

PRODUCT FORM	REFERENCE NAME AND GENERAL DESCRIPTION	ACCEPTED MAX. TEMP.[a] DEGREES F	ASTM SPECIFICATIONS[b]	MILITARY (MIL) and MARITIME (MA) SPECIFICATIONS[b]	FEDERAL SPECIFICATIONS[b]
PIPE INSULATION	ASBESTOS (Molded Amosite and Binder)	1200		MIL-I-2781 Grade II, Class c Grade III, Class f	HH-I-561, Type IV
	CALCIUM SILICATE (Calcium Silicate and Asbestos)	1200	C-345	MIL-I-2781 Grade I, Class b Grade II, Class d Grade III, Class e, Type I	HH-I-523, Class 2
	CELLULAR GLASS (Foamed, Fabricated from Block)	800	C-381		HH-I-551
	CELLULAR SILICA (Foamed, Fabricated from Block)	1600 (cyclic) 2200 (cont.)			
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1600 1900	C-334 C-334	MIL-I-2781 Grade III, Class e, Type II	
	85% MAGNESIA (Basic Magnesium Carbonate and Asbestos)	600	C-320	MIL-I-2781 Grade I, Class b	HH-I-554, Type II
	MINERAL FIBER (Rock, Slag or Glass) Low Temp (Organic Binder)	250	C-300		HH-I-562, Type II HH-I-552, Type I
	Low and Medium Temp (Fine Fiber, Organic Binder)	370	C-281 C-300	MIL-I-22344	HH-I-562, Type II HH-I-552, Type I
	High Temp (Blanket-Type Metal Reinforced)	1200	C-280		HH-I-552, Type II
BLOCKS and BOARDS	CALCIUM SILICATE (Calcium Silicate and Asbestos)	1200	C-344	MIL-I-2819, Classes a & b MIL-I-002819, Classes 1 & 2	HH-I-523, Class 1
	CELLULAR GLASS (Foamed)	800	C-343		HH-I-551
	CELLULAR SILICA (Foamed)	1600 (cyclic) 2200 (cont.)			
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1600 1900	C-333 C-333	MIL-I-2819, Classes b & c MIL-I-002819, Class 3 MIL-I-002819, Class 4	
	85% MAGNESIA (Basic Magnesium Carbonate and Asbestos)	600	C-319	MIL-I-2819, Class a MIL-I-002819, Class 1	HH-I-554, Type I
	MINERAL FIBER (Rock, Slag or Glass) Low Temp (Organic Binder)	250	C-378	32-MC-2[c] MIL-I-742[d]	HH-I-564, Class A HH-I-526, (for Roofs) HH-I-562, Type I
	Low Temp (Fine Fiber, Organic Binder)	400	C-378, C-392, Class 1		HH-I-562, Type I
	High Temp (inorganic Binder)	1800	C-392, Class 2		HH-I-564, Class B, C, D
CEMENTS	CALCIUM SILICATE (Calcium Silicate, Asbestos and Binders)	1200			HH-I-523, Class 3
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1900	C-197	MIL-C-2861, Type A	HH-I-00500, Type V
	MAGNESIA (Basic Magnesium Carbonate, Asbestos and Binder)	600	C-193	MIL-P-2886	HH-I-00500, Type I
	MINERAL FIBER (Rock, Slag or Glass) Insulating (Colloidal Clay and Binder)	1800	C-195	MIL-C-2861, Type B	HH-I-00500, Type III HH-C-168
	Finishing (Hydraulic-setting Cement and Binder)	1200	C-449	MIL-C-2908, Type II	
BLANKETS and FELTS	MINERAL FIBER (Rock, Slag or Glass) Metal-Reinforced Blanket	1200	C-263	MIL-I-2818	HH-I-563, Type I
	Flexible (Organic Bonded)	400	C-264 C-382	MIL-I-942 MIL-I-22023[f] MIL-B-5924 } [e] MIL-I-16688 MIL-I-7171 } [e] 32-MA-3[c] MIL-I-15475	HH-I-542, Type I
	Industrial Batt (No Binder)	1200	C-262	MIL-W-15427	
	Felt (Semi Rigid, Organic Bonded)	400	C-264 C-382	MIL-I-16688 } [g] MIL-I-942 MIL-I-15475 } [g] 32-MC-1[c]	HH-I-521, Type I HH-I-542, Type II HH-I-563, Type II
LOOSE and GRANULATED	MINERAL FIBER (Rock, Slag or Glass)	1200			HH-I-521, Type I—Loose Type II—Gran

(a) These temperatures are generally accepted as maximum. For specific applications consult the manufacturer. (b) See latest revisions of these specification numbers. In columns where no specification number appears, no specifications have yet been adopted. (c) Specifications 32-MC-1 and -2 and 32-MA-3 apply to Maritime Administration use only. (d) Specification MIL-I-742 applies to special mineral fiber board used by the Navy for hull and duct insulation. (e) Specifications MIL-B-5924 and MIL-I-7171 apply to glass fiber batting and blanket for thermal and acoustical insulation of aircraft compartments. (f) Supersedes MIL-I-15365 and MIL-I-16022. (g) Specifications MIL-I-15475 and MIL-I-16688 apply to Naval cold storage and refrigeration spaces, etc

A Nalco DEPARTMENT MANAGER

Answers the Questions Most Often Asked About Nalco Water Treatment Consulting Service

Experts Extend Your Staff Potential for Fast, Economical Handling of System Design, Chemical and Equipment Selection, and Plant Operations.

Question: If a company's staff includes qualified design and operating personnel, why is Nalco Consulting Service needed?

Answer: Design, modification, improvement, and achievement of maximum economy in operation of water treatment facilities are highly specialized chemical engineering fields. Constant research and long experience in these fields enable Nalco engineers to supplement—*not* replace—the efforts of a company's staff by providing up-to-date information in their special fields.

Question: How does Nalco Consulting Service differ from the services of design consulting engineers?

Answer: Again, remember the specialized nature of water treatment engineering. Rarely can a company or consulting firm afford to maintain a staff of engineers who devote their entire energies to water treatment. Nalco, however, *does* have such a group of water treatment specialists that can act as an extension to the staff of the design engineer. These men have not only knowledge and experience in the intricacies of each of the specialized areas of water treatment, but the constant association with the rapidly changing technology of the field required to keep their information accurate and up-to-date.

Question: What return on investment does the cost of a Nalco consulting program provide?

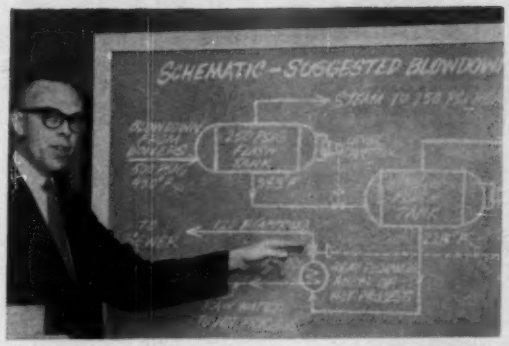
Answer: Nalco Consulting Service reduces plant construction costs and saves *your* engineers' time. For example, assume that you need a new or completely modernized ion exchange water treatment plant. Nalco Consulting Service will help your engineers and/or design consultants establish the basic type and size of plant needed, *before* requests for bids are issued. Potential suppliers can then return bids faster and more economically. Also, your engineers can evaluate bids in a fraction of the time required for evaluation of bids on a variety of plant types. This reduces the overall cost of the system and releases the men involved for other projects.

Question: How is Nalco Consulting Service useful to an existing plant for which no immediate expansion is planned?

Answer: Few plants require or can afford a *full-time* water conditioning engineer – yet *all* plants find at times that they need the services of such an engineer. Nalco meets this need by supplying plant operators with the assistance they need, when they need it, to an extent determined by mutual agreement. Consulting service prevents many problems before they occur by anticipating the need for changes in chemical treatment control and application—giving you maximum benefit from every dollar spent on water treatment chemicals.

Question: Isn't consulting service usually supplied, free of charge, with the purchase of water treatment chemicals?

Answer: *Product application assistance* is offered for specific chemicals. Consulting provides an overall *program*. The complexity of many of today's systems requires attention to all phases of operations. While product application assistance is an important Nalco service to industry, often it should be supplemented with a consulting arrangement which provides the intensive and effective integration of *all* water treatment into a successful program.



Selden K. Adkins, Manager, Nalco Consulting Service Department

Question: What do you mean when you say "the highly specialized nature" of chemical engineering as applied to water conditioning?

Answer: No one engineer can know every single detail that is important in each phase of an overall water treatment program. Coagulation, filtration, stabilization, softening, sludge conditioning, ion exchange, slime and microbiological control—all these and many more must be considered. Nalco's coagulation, stabilization, power industry chemicals, process antifoams, cooling water, and microbiology departments maintain an effective working knowledge of each of these special areas of water treatment. Each department manager is an expert in his given field, and is assisted by an average of 25 staff and laboratory personnel. Nalco's Consulting Department draws on the specialized knowledge of each of these groups to provide the engineering knowledge needed in each plant. By coordinating the efforts of all these specialists and utilizing the knowledge and experience of our national field force, Nalco can provide precise information to get successful results. That so many departments are vital in our operations indicates the degree of specialization necessary.

Question: How can a company that sells chemicals be a "true" or impartial consultant?

Answer: Regardless of affiliation, consultants are responsible for producing effective results. Nalco consultants have nothing to gain—and everything to lose—by recommending any chemical or method not in the best interest of the client. Water treatment products offered by Nalco (or any reputable company of this type) are usually special blends, each designed to do a specific job under a specific set of conditions. These specialized products would not exist if there was an *exact* equivalent "open market" chemical available. The Nalco Consulting Department recommends the most suitable chemical for a given situation—regardless of whether or not it is a Nalco product. The single objective of Nalco Consulting Service is to provide the client with maximum treatment efficiency, regardless of which chemical or equipment is used. Chemicals are no more than tools to the consulting engineer—what he provides are programs, methods, and results.

Suggestion: Write or ask your Nalco Field Representative for information on how Nalco Consulting Service can be of help in *your* water treatment program.

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CONSTRUCTION NEWS

Pine Bluff, Ark. — International Paper Company, 220 E. 42 St, New York, N. Y., has authorized plans and will begin construction at once on a third paper mill addition and groundwood mill addition to company's paper mill located here. Work will include the installation of a recovery boiler and major additions to existing power plant. Work already under way is scheduled for completion by early 1962. Cost of the total additions and installations, under company's own forces, reported to be about $13,000,000.

Morro Bay, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif, has announced application to the California Public Utilities Commission, for permission to construct an additional generating facility at power station located here. Company has plans for an additional steam-electric generating unit with an initial capacity of 325,000 kw at a cost reported to be about $46,000,000. Work will get under way at once for completion scheduled for the fourth quarter of 1962 or the early part of 1963. When completed, plant's total generating capacity will be in excess of 655,000 kw.

Pueblo, Colo. — San Isabel Electric Association, 316 W. 15th St, this city, Southeastern Colorado Power Association, 901 W. 3rd St, La Junta, Colo., and Sangre de Cristo Electric Co, Salida, Colo., have announced plans for the construction of a new power plant to cost in excess of $10,000,000 to serve their combined areas. Plant will have an initial capacity of 44,000 kw and will be erected under the supervision of Ellerbe & Co, 333 Sibley St, St. Paul, Minn., consulting engineer of the project. Work on the new facility will get under way at once for completion in about two years.

Newton, Conn. — State Public Works Commissioners, State of Connecticut, 165 Capitol Ave, Hartford, Conn., has authorized plans for major improvements in electrical system at Fairfield State Hospital, located here. Work on the improvement project will get under way at once for completion by late fall of 1961. No estimate of cost of the installations announced.

Pierce, Fla. — Florida Power Corp, St. Petersburg, and Tampa Electric Co, Tampa, have announced a delay of from one to two years on the planned construction of a 50,000-kw nuclear power plant scheduled to be constructed on large site here. Companies stated that further research was needed to determine the feasibility of using beryllium instead of stainless steel as the cladding material for the plant's reactor. Another delay factor was the necessity for reaching a cost agreement with the 14 electric utility companies participating in the project. Florida Power and Tampa Electric were to build and operate the plant at their own expense, providing the cost was no more than 1½ times as much as a conventional power plant of equal size.

Steelville, Ill. — Southern Illinois Power Cooperative, Inc, Dongola, Ill., has authorized plans and will soon let contracts for steam generating equipment for company's new power plant to be erected here on the South Fork of the Saline River, just south of Marion, Ill. Work on the plant which will have an initial capacity of 99,000 kw will get under way immediately for completion in the summer of 1962. Cost of the facility reported to be in excess of $21,000,000. Burns & McDonnell Engineering Co, 4600 E. 63rd St, Kansas City, Mo., is the engineer of the project.

Plainfield, Ind. — Public Service Company of Indiana, 1000 Main Street, this city, has authorized plans for a major addition and improvement program at company's power substation located here. Work on the new project will begin at once for completion scheduled for late 1961. Large addition to present facility will be constructed at Stop 8 Road, east of the N. Y. Central R. R. tracks. Cost of the work when completed is reported to be in excess of $2,250,000.

Morgan City, La. — City Council, City Hall, Morgan City, has plans in progress for expansions and improvements in municipal power plant, with installation of a new 6250-kw turbine-generator unit and auxiliary equipment. Work on the installation will begin at once and is scheduled for completion by the spring of 1962. Plans for the installation, by Albert Switzer & Associates, 4529 N. Boulevard, Baton Rouge, La., have been approved and when completed will represent an investment in excess of $1,200,000.

St. Louis, Mo. — Board of Trustees, Sisters of Mercy, St. John's Hospital, 307 South Euclid Ave, St. Louis, Mo., has authorized plans for the construction of a multi-million dollar hospital, including a nursing home and school, convent, chapel, gymnasium, power plant and laundry on large site here. Structure will be of 12 stories, including an 11-story nurses' home and school. Work on the new facility will get under way at once for completion in the summer of 1962. Contract for the work has been let to the C. Rallo Contracting Co, Inc, 5000 Kemper Ave, this city, in the amount of $6,517,853.

Forked River, N. J. — Jersey Central Power & Light Co, 501 Grand Ave, Asbury Park, N. J., has plans under consideration for the construction of a large power plant near here on a site of 850 acres which is under option pending test boring findings to determine whether the land substrata would support the weight of a power plant. First phase of construction would be a 250,000-kw generating unit installation which would cost approximately $50,000,000. Construction of the unit will probably not begin until 1963 and will take three years to complete. Plant will be the first generating plant constructed by the company south of the Raritan River. Plant when completed will employ about 150 persons and have an annual payroll of about $1,000,000.

Ship Rock, N. M. — Arizona Public Service Co, Phoenix, Ariz., and Utah Construction & Mining Co, San Francisco, Calif, have been granted permission from the Navajo Tribal Council, Window Rock, Ariz., to erect a coal-burning, steam-electric power plant and transmission lines on the Navajo Reservation. The agreement calls for the construction of a $100,000,000 generating plant with an initial capacity of 350,000 kw on 1250 leased acres southeast of this place. Fuel will be mined and furnished by Utah Construction from approximately 24,000 acres of undeveloped tribal lands leased by the company. Coal mining royalties alone will give the tribe an income of from $225,000 to $900,000 per year. Work on the project will get under way at once.

Eugene, Ore. — Eugene Water & Electric Board, Eugene, Ore., has announced contract award in the amount of $14,797,498 to the Peter Kiewit & Son Co of 1024 Omaha National Bank Building, Omaha, Neb., in connection with construction of the main section of proposed 90,000-kw Carmen-Smith hydroelectric project on the upper McKenzie River. Board has just awarded an electric system revenue bond issue in the amount of $25,500,000 to carry on the work which is scheduled to be completed in late 1962.

Peach Bottom, Pa. — Philadelphia Electric Co, 1000 Chestnut St, Philadelphia, Pa., has announced that company has filed with the Atomic Energy Commission an application to construct a 40,000-kw atomic power plant on a large site here on the Susquehanna River. Cost of the plant including research and development of the reactor and generating system will approximate $40,000,000. AEC will provide $14,500,000 for research, Philadelphia Electric Co $8,000,000, and $16,500,000 will come from 52 electric utilities who make up the High Temperature Reactor Development Associates, Inc, formed two years ago. Plant will be a high temperature power station cooled by helium gas and moderated by graphite and will be completed in the fourth quarter of 1963.

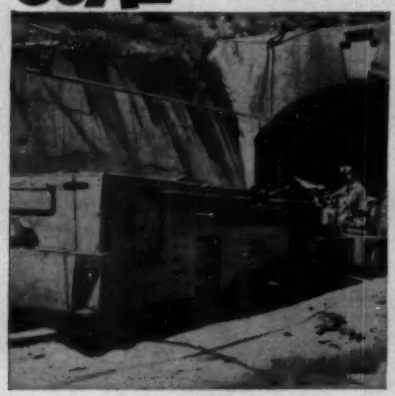
Pittsburgh, Pa. — Westinghouse Electric International Co, a New York Division of Westinghouse Electric Corp, has announced receipt of a $20,000,000 contract for a 225,000-kw power station near the Mexican border town of Tijuana. The order placed by Mexico's Commission Federal de Electricidad calls for the installation of three 75,000-kw steam electric generating units and auxiliary equipment representing the largest single export order for steam electric power equipment ever received by the company. The oceanside plant, located 10 miles south of the United States border, is among the first of an announced $1,000,000,000 program of electrical development geared to double Mexico's total installed capacity in the next five years.

Rapid City, S. D. — Black Hills Power & Light Co, 621 Sixth St, has announced the acquisition of the electric properties of Central Electric & Gas Co, Sioux Falls, S. D., in three towns and adjacent rural areas. The towns, all in South Dakota, are Hot Springs, Buffalo Gap and Oral. Purchase effective August 1st, last, was made for an undisclosed amount in cash. Total revenues of the properties purchased approximate $300,000 annually. However, since the Black Hills Co has been wholesaling electricity to the Central Electric facilities, the net gain in revenues would be substantially less.

Continued on page 100

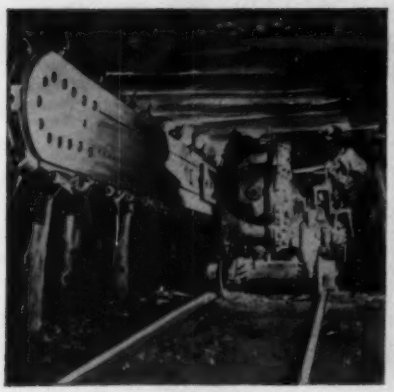
BEACON COAL HAS WHAT IT TAKES

MEN



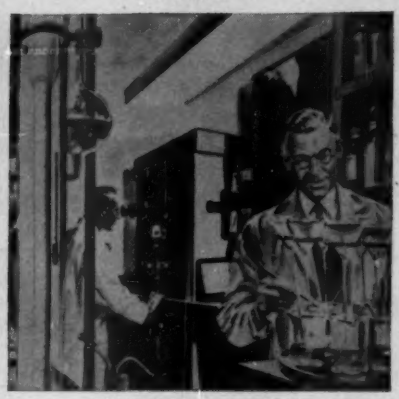
MINES

CAPACITY



EQUIPMENT

PREPARATION



QUALITY CONTROL

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We have been serving electric utilities for many years, and feel that we know intimately their needs and problems. Our 15 mines provide a variety of coals, and a potential that can deliver up to 15 million tons a year at need. Modern mechanization plus skilled miners equip us to gear production to virtually any emergency you might encounter, and mine location on a number of major railroads gives wide latitude in routing. We maintain close check on quality in our laboratories. Our representatives are men who have made coal their life work and the serving of customers their highest aim. Finally, our past record, if you care to check it, provides complete assurance that you will get the coal you want, when, where, and as you want it.

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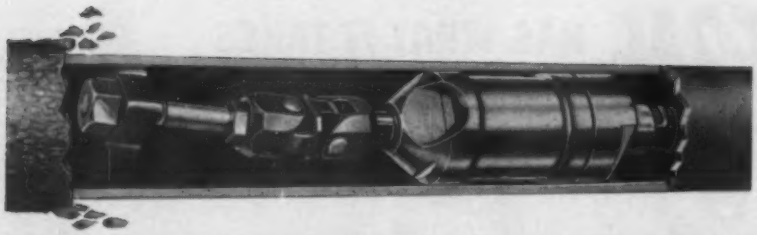

ROTOJET®

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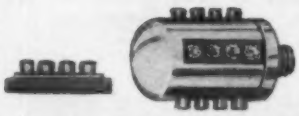
INSIDE *and* OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

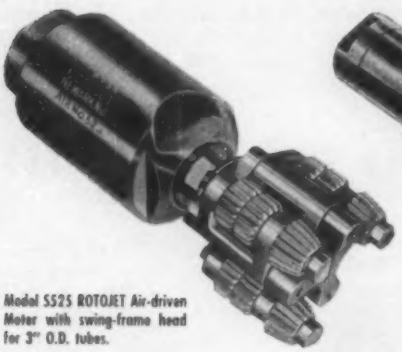
Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model SS2S ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model SS0S ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

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Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

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CONSTRUCTION NEWS

Continued from page 98

Sioux Falls, S. D. — Northern States Power Co, 15 S. Fifth St, Minneapolis, Minn., has authorized plans and work will get under way at once on construction of transformer installations at' company's substation located here. Work to be done under company's own forces is scheduled for completion by the third quarter of 1961. Cost of the project reported to be in excess of $281,000 when completed.

Austin, Texas — City Council, City Hall, has plans in progress for expansion and improvement in municipal power plant, with installation of new hydroelectric power plant to cost approximately $18,800,000. Preliminary work on the ground installations is already under way and the plant is scheduled for completion by the third quarter of 1962. Council has also approved improvements to existing plants in the amount of $1,000,000, work on three substations in the amount of $2,200,000; transformers, distribution circuits, services, meters, etc., $2,000,000; and new and improved electric transmission lines at a cost of $4,000,000. Appropriation will be authorized by bond issue.

Washington, D. C. — Atomic Energy Commission, 1901 Constitution Ave, N.W., this city, has authorized the selection of a proposal by the Martin Co of Baltimore, Md., as a basis for contract negotiations for supplying a packaged nuclear power plant for McMurdo Sound in Antarctica. The AEC contract calls for a 1500 electric kilowatt reactor of the pressurized water type at a fixed price not to exceed $3,950,678. Under the contract Martin Co will design, fabricate, assemble and test-operate the plant. It will be shipped to McMurdo Sound in units for final assembly and is to be in operation by the spring of 1962. This is the first of three reactors AEC is scheduled to provide for Navy use in Antarctica.

New Reprints

"Successful Training for Power Plant Operators" is off the press and available now. This POWER ENGINEERING series began in 1958 and includes nine articles on problems of training for an industrial power plant and maintenance, and training power plant supervisors and on-the-job graduate engineers.

Our recently completed Motor Bearings series is also available now. This eight-page reprint details applications and types of motor bearings used on equipment usually operated by power engineers. Proper lubrication is also discussed.

For single copies of either reprint write The Editor, POWER ENGINEERING, 308 E. James St, Barrington, Ill. Quantity lot prices will be quoted on request.

Another addition to the Vogt line of TOP QUALITY valves . . .

Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

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Series 2801 Gate Valve
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Both series identical in dimensions and have 13% chrome stainless steel trim.

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FORGED STEEL

VALVES

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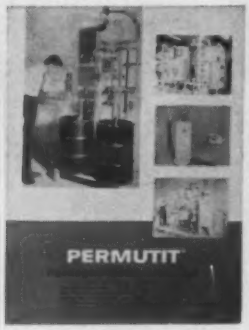
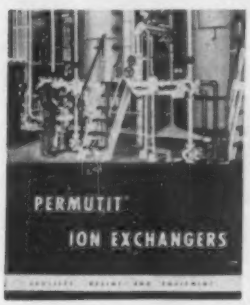
High-capacity water softening: New Permutit® Model BD Softeners answer industry's needs for more soft water at lower cost. Full details on operation, specifications and performance are contained in **Bulletin 4696.**



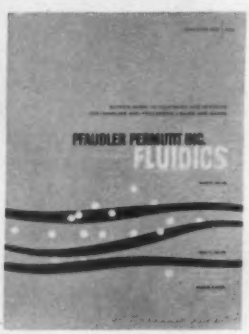
Standard packaged demineralizers: Factory-assembled, systems ready to connect and operate. For summary of applications, plus data on mixed-bed, two-step, non-regenerable and skid-mounted units, send for **Bulletin 4721.**

Automatic valveless gravity filter: Costs up to 45% less than conventional filters. Also saves money after installation, because it operates automatically without a single valve, agitator, pump, flow controller, or an attendant operator. **Bulletin 4351.**

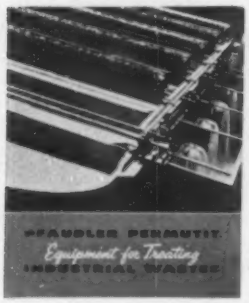


Ion exchangers: From Permutit—the only company to manufacture ion exchange resins and the equipment in which they are used—a manual on ion exchange as a unit process for purification, recovery, addition, separation, concentration. **Bulletin 2508** also covers resins and equipment.

"New" metals for processing: Tantalum, titanium and zirconium are finding increased use because of their exceptional corrosion resistance and strength. Corrosion, heat transfer and general application data on these metals, plus equipment available, see **Bulletin 978.**



How FLUIDICS works for you: Buyer's Guide surveys equipment for water and waste treatment, ion exchange, gas analysis, metering and control. Also equipment for handling corrosives, heat transfer, reactions, centrifuging and packaging. Send for **Bulletin 992.**



Permutit Precipitator: Saves about 50% in ground space, 50%-75% in time of treatment, and 10%-40% in certain chemicals and adsorbents, compared to conventional reaction and settling tank. Complete facts on operation and applications are in **Bulletin 2204C.**

Water treatment chemicals: Permutit offers an extensive line of specialized chemicals. Typical data available: **Bulletin CS-105** on Wisprofloc-20 Coagulant Aid, **Bulletin CS-111** on Neutralizing Amines, **Bulletin CS-110** on the Briquet System.

Deaerating Heaters: Designed for removal of carbon dioxide and oxygen from boiler feedwater. Permutit offers both Spray Deaerators, **Bulletin 2357,** and Tray Deaerators, **Bulletin 4732.**

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New Engineering Books

Organizing the Technical Conference, by Herbert S. Kindler; 139 pages; 6 by 9 in.; cloth binding. Published by Reinhold Publishing Corp, Dept J, 430 Park Ave, New York 22, New York. Price $6.

For any engineer who desires, or who is ordered, to plan or participate in a conference, this book will be a most practical and invaluable guide and working manual. Its author is director of Technical and Educational Services of the Instrument Society of America.

The book is not intended to show the reader how to organize a conference or convention in which attendance ranges into the thousands, because such mammoth meetings are usually administered with paid staff assistants. Instead, discussion is focused on organizing smaller gatherings considered by most technical leaders to be more effective for person-to-person communication. All the ideas offered assume that the conference manpower consists of volunteers.

No single plan for organizing a conference exists. But all the conference techniques described in this book have been tried successfully. However, all conferences have one problem in common: they require action so far in advance of the actual meeting that the conference planners cannot afford to learn as they go along.

Consequently, the book begins with a chapter entitled: Are Technical Conferences Really Necessary? It then goes on to give in great detail the necessary steps in initial planning of the conference. Following this are details on developing the program, and on organizing auxiliary supporting and servicing activities, such as lecture series, clinics, students' days, banquets, ladies' program, and the like.

There is a very good and detailed chapter on promotion and public relations, both before and after the conference. Next is a chapter on documentation of the conference, such as preprints, review of technical papers, printing problems, editing, and so on.

Another chapter discusses the conference gathering, evaluation of the conference, and any followup action required or possible. Still another chapter gives specific data on the actual conduct of the conference by the chairman and the conferers.

One of the interesting items given in an appendix is a conference success rating form. This takes into account such factors as the quality of information presented, the quality of its presentation, the feedback, and the environment rating. These are expressed in mathematical equations, and a typical example shows how the rating of a particular conference comes out to be 0.42, which is a good 420 batting average.

Because many engineers have to organize

Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

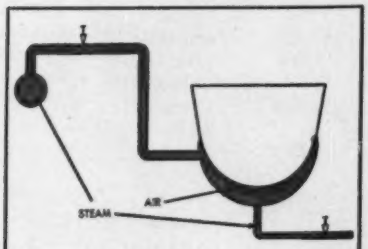


Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

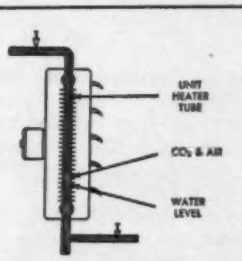


Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. CO_2 gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O_2 aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume)	
		10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4

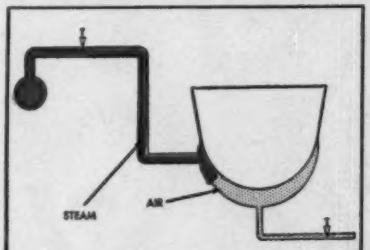


Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

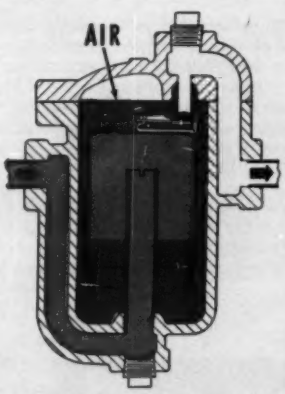
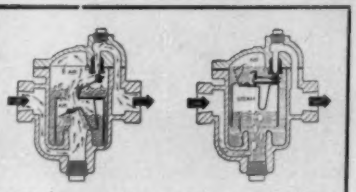


Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



Thermostatic vent open. *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8104 Maple Street, Three Rivers, Michigan.

ARMSTRONG STEAM TRAPS

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ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling

Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

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***Other related accessories* include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.**

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and conduct relatively small technical conferences, this book should be a delight to the harried committeeman and an invaluable aid to him in producing a crisp, businesslike approach to a usual area of confusion. If he follows the procedures detailed here, he will have a very effective conference.

★ ★ ★

Transformers and Generators for Power Systems, by R. Langlois-Berthelot; 541 pages, 5½ by 8½ in. Published by Philosophical Library Inc, 15 E. 40th St, New York 16, N. Y. Price $12.

Translated and revised in collaboration with Lieut-Col. H. M. Clarke, this book is divided into two parts. The first part deals with the transformer, and the second part with the synchronous machine. A valuable feature included as one of the appendices is a complete survey of the articles referring to the subjects that have appeared in British, American, and French engineering journals. Although a complete volume in itself, this book develops the ideas set out in the author's previous work, *Electro-Magnetic Machines*.

Charles F. Wagner, consulting electrical engineer to Westinghouse Electric Corp, points out in the *foreword* that the author has aimed at simplification. Because of the restraint he has exercised in refraining from too detailed explanations and by the systematic clarification of the subject, it is an easy book to read. The book stresses practical information, orders of magnitude, a sense of proportion, guiding comments, significant factors of design and application — all with sound reasoning.

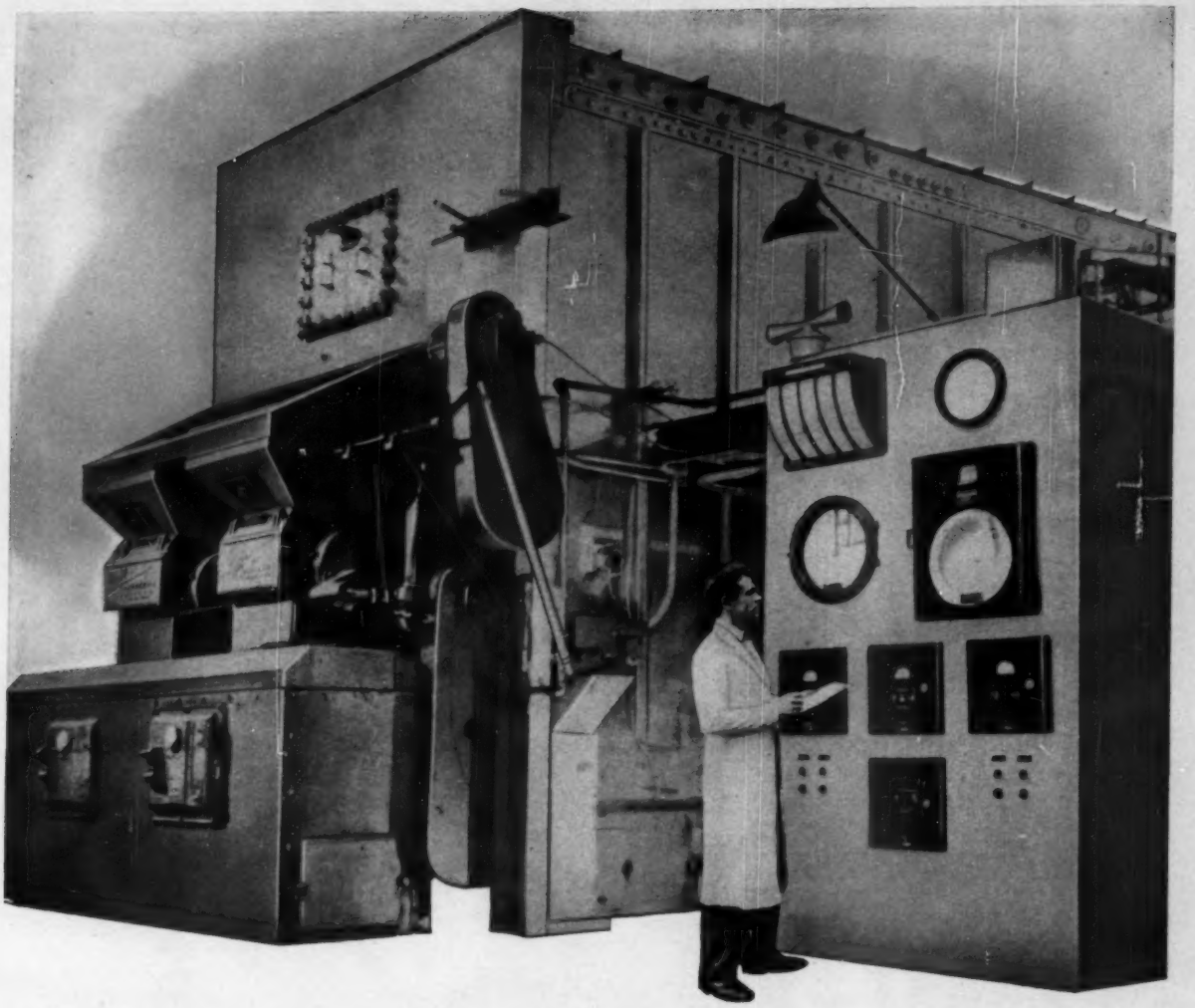
In this day of computers, the designer is apt to lose much of the instinct and judgment that develops from continuous adjustment and reappraisal of factors that lead to the final design. It is fortunate, therefore, that a book of this character appears at this time — a book that discusses the essentials of design, a book whose author through actual experience has passed through this process and has recorded these fundamentals.

★ ★ ★

Statistical Yearbook of the United Nations, 1959, eleventh issue; 622 pages, paperbound, 9 by 11½ in. Published by the Statistical Office of the United Nations, Department of Economic and Social Affairs, New York, N. Y., 1959.

Only an organization as vast and well-integrated as the United Nations could have undertaken and completed a project as wide in scope as this eleventh issue of the *Statistical Yearbook*. Information was compiled and coördinated by the Statistical Office of the United Nations in coöperation with the national statistical offices of more than 150 countries and in conjunction with the assistance of the specialized agencies of the UN and certain other intergovernmental bodies.

A partial review of the topic headings reveals compiled data on population, manpower, agriculture, manufacturing, mining, consumption of goods, communications,



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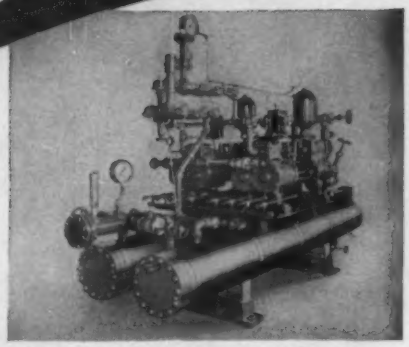

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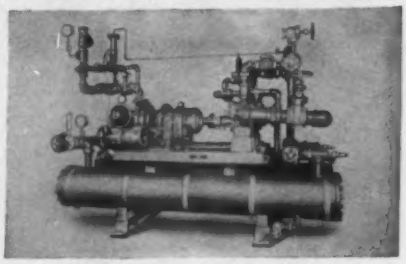
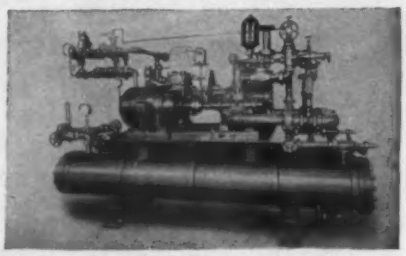


One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

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OB-37 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

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national income, wages and prices, and education.

Of special interest to many power engineers is the section on installed capacity in electric energy of the countries submitting data on their installations. In addition, a special section on energy itemizes production, trade, and consumption figures on coal, lignite, crude petroleum, natural gas, and hydroelectricity.

The tables and statistical data presented should not be viewed as numbers alone. Their true significance can be seen as a comparative evaluation of economic weaknesses and strengths, areas of growth and stagnation, and areas of plentiful natural resources and those of few. In order to understand many of today's world developments, it is perhaps also necessary to understand some of the economic problems facing various nations.

★ ★ ★

American Standard for Industrial Control Apparatus; 37 pages, 8½ by 11 in., paperbound. Published by American Institute of Electrical Engineers, 33 W. 39th St, New York 18, N. Y.

This is a revision of the 1943 edition, and is numbered AIEE No. 15, ASA C19.1 1959, UDC 621.316.7.

This Standard covers devices, whether electric, magnetic, mechanical or electronic, which are intended to function on commercial voltages of 750 volts or less dc and 500 volts or less ac.

Devices covered include the following: Contactors, drum switches, photoelectric relays, autotransformers used for starters, reactors, rheostats, relays, resistors, switch devices, solenoids and magnets, electromagnetic brakes, electronic regulators, electronic inspection and gaging apparatus.

★ ★ ★

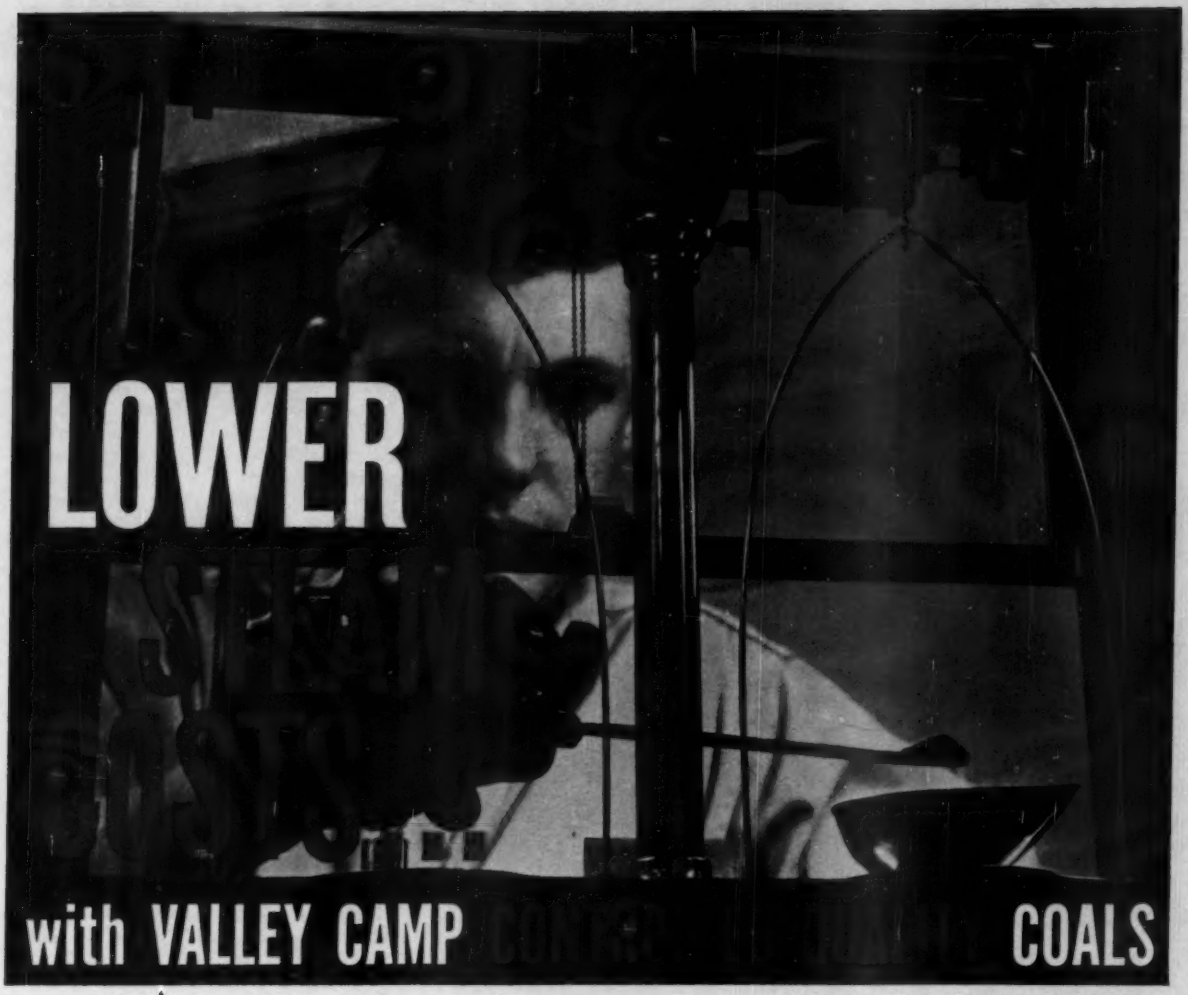
Elementary Theoretical Fluid Mechanics, by Karl Brenkert, Jr; 348 pages, 6 by 9¼ in. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y.

Contrasting with most other engineering texts having the word "elementary" in the title, this book includes a great deal of calculus. Maximum stress is put on the "theoretical" aspects, and the fundamental equations are developed in their most general form.

Empirical data and specific formulae are reduced to less than those in any other book in the field. The intent is to present fundamental material in a rigorous manner but without overstepping the limits of a beginner's comprehension.

Many examples are given of varying degrees of difficulty to give the reader confidence in his mathematics, and to demonstrate the wide variety of problems which he can solve with the general form of the fundamental equations.

Potential theory is introduced in the last chapter. Though ordinarily beyond the scope of an elementary text, the author included it to let the student know that such a theory exists, and to give him an opportunity to start his education on wing theory.



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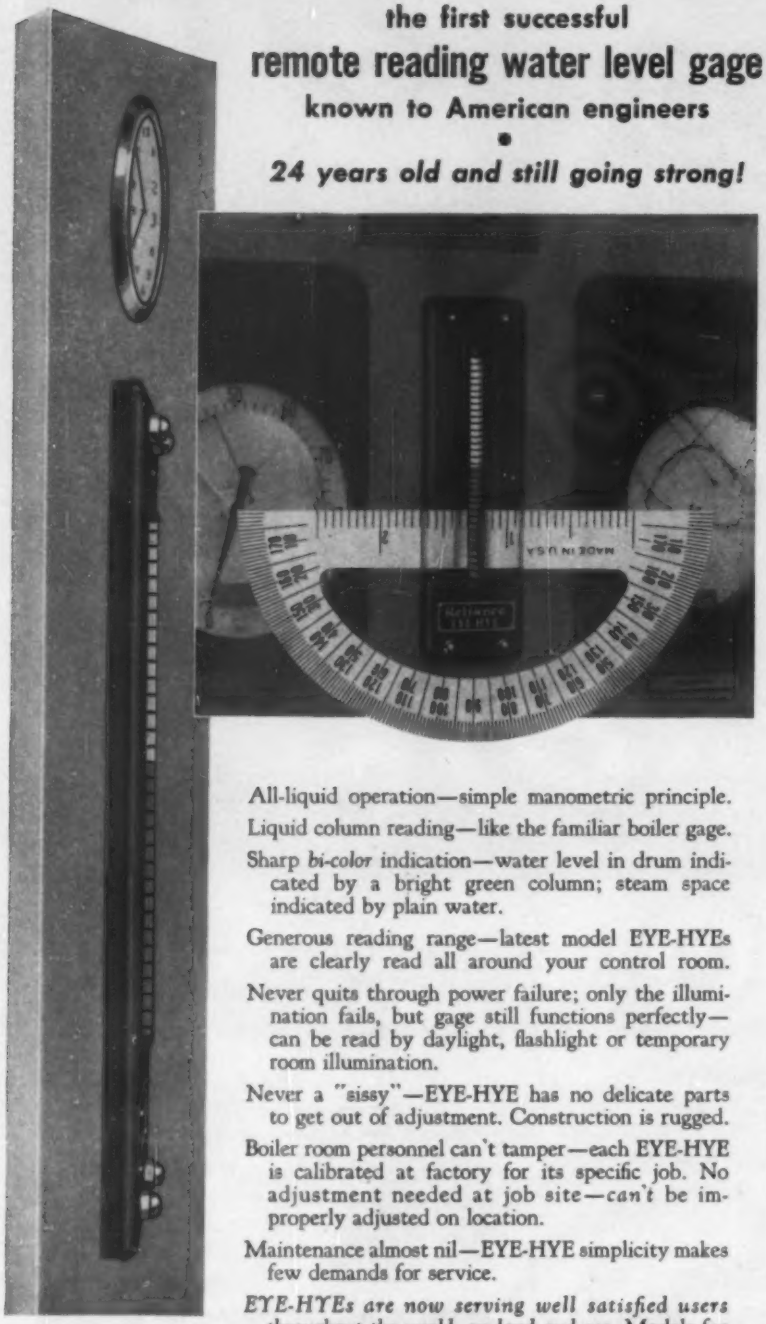

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FEDERAL AGENCY POWER NOTES

» **Alabama Power Co,** of Birmingham, has been authorized by the FPC to construct a $40,986,000 hydroelectric development on the Coosa River in Chilton, Coosa, and Elmore counties in Alabama.

The new development will consist of an intake canal beginning at a point about one mile upstream from the existing Jordan No. 1 dam and extending westerly from Jordan Lake to a forebay lake; a forebay formed by earth embankments; a powerhouse with two 103,600-hp turbines, each connected to a 75,000-kw generator, with provision for a third similar unit; and appurtenant facilities.

» **Bureau of Reclamation,** Dept. of the Interior, has announced award of the first contract to initiate construction of the $7.5 million Greater Wenatchee Div of the Chief Joseph Dam Project in Washington.

Worthington Corp's bid was accepted, and the firm will furnish four motor-driven, vertical-shaft turbine-type pumping units for the river pumping plant of the East Unit. These pumps will deliver water through a booster plant to a 2,000,000-gal storage reservoir, from which the water will flow under pressure to a sprinkler-type irrigation system that will serve 4460 acres of high value fruit lands.

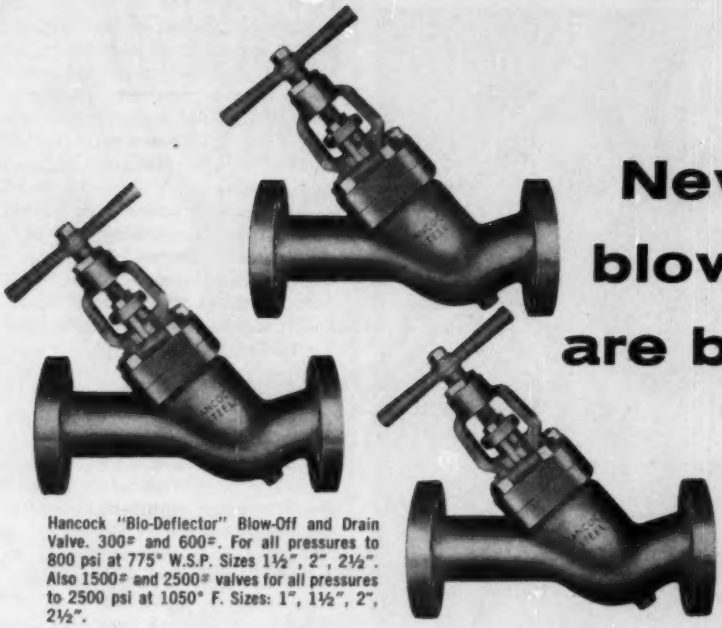
Plans call for completion of the East Unit in two years. The pumping plant, which will be constructed on the Columbia River approximately six miles east of the town of Wenatchee, is scheduled to go under contract this winter.

Riverside and booster pumps will have a capacity for delivering water from the Columbia River at a rate of 76 cfs. Pump lift will be about 700 ft.

» **Tentative approval** was given by FPC to Atlantic Seaboard Corp, of Charleston, W. Va., to construct natural gas pipeline facilities costing about $1,946,300. Project will consist of 13.4 miles of 26-in., and about 6.4 miles of 20-in., loop pipeline in Virginia and Maryland. Increased requirements anticipated this winter necessitates increased capacity on the company's Cobb-Baltimore pipeline.

» **On petition** from Northern Natural Gas Co, of Omaha, Nebr., FPC has amended a certificate which had authorized the firm to undertake large-scale construction. On July 31, 1959, Northern was authorized to

New Hancock blow-off valves are boiler tough



Hancock "Blo-Deflector" Blow-Off and Drain Valve. 300# and 600#. For all pressures to 800 psi at 775° W.S.P. Sizes 1½", 2", 2½". Also 1500# and 2500# valves for all pressures to 2500 psi at 1050° F. Sizes: 1", 1½", 2", 2½".

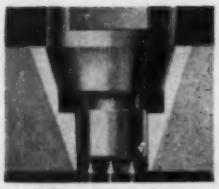
Forget about plungers, springs, lubricating fittings and special packing, or seat threads. These new Hancock 300# and 600# Blow-Off and Drain Valves are simply designed and constructed. But that only partly explains why they rarely need attention and last for the life of your boiler.

The unique "Blo-Deflector" seat and disc makes it impossible for fast-moving water to cut the disc's seating surface.

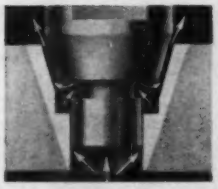
There is no wire drawing or erosion because both integral seat and the disc are Stellite faced. Shut-off is tight and dependable; no costly losses of heated boiler water.

No bonnet joint leaks, either! Properly compressed between the thick body and bonnet flanges is a recessed Flexitallic sealing gasket that cannot blow out.

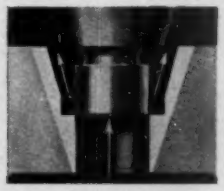
Hancock Blow-Off and Drain Valves always operate easily; no stem binding. They can be repacked under pressure, and surpass all stationary and marine codes, and insurance requirements. Your industrial supply distributor will gladly give you more details. Write for Bulletin 235.



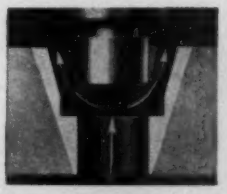
The Hancock "Blo-Deflector" valve seat and disc in the closed position. Pressure from the boiler is indicated pushing upwards under the valve disc.



As the valve starts to open, a small amount of water shoots upward . . . loses its fight as it hits the protecting lip and washes harmlessly across the seat as the valve is opened further.



When the piston leaves its guide, the seating surface of the disc is completely out of the line of flow. This makes it impossible for the velocity of the water to cut the seating surface of the disc.



Above picture shows valve in open position. Observe that neither shut-off surface is affected by the flow. Resulting in long, repair-free life of these "Blo-Deflector" Hancocks.

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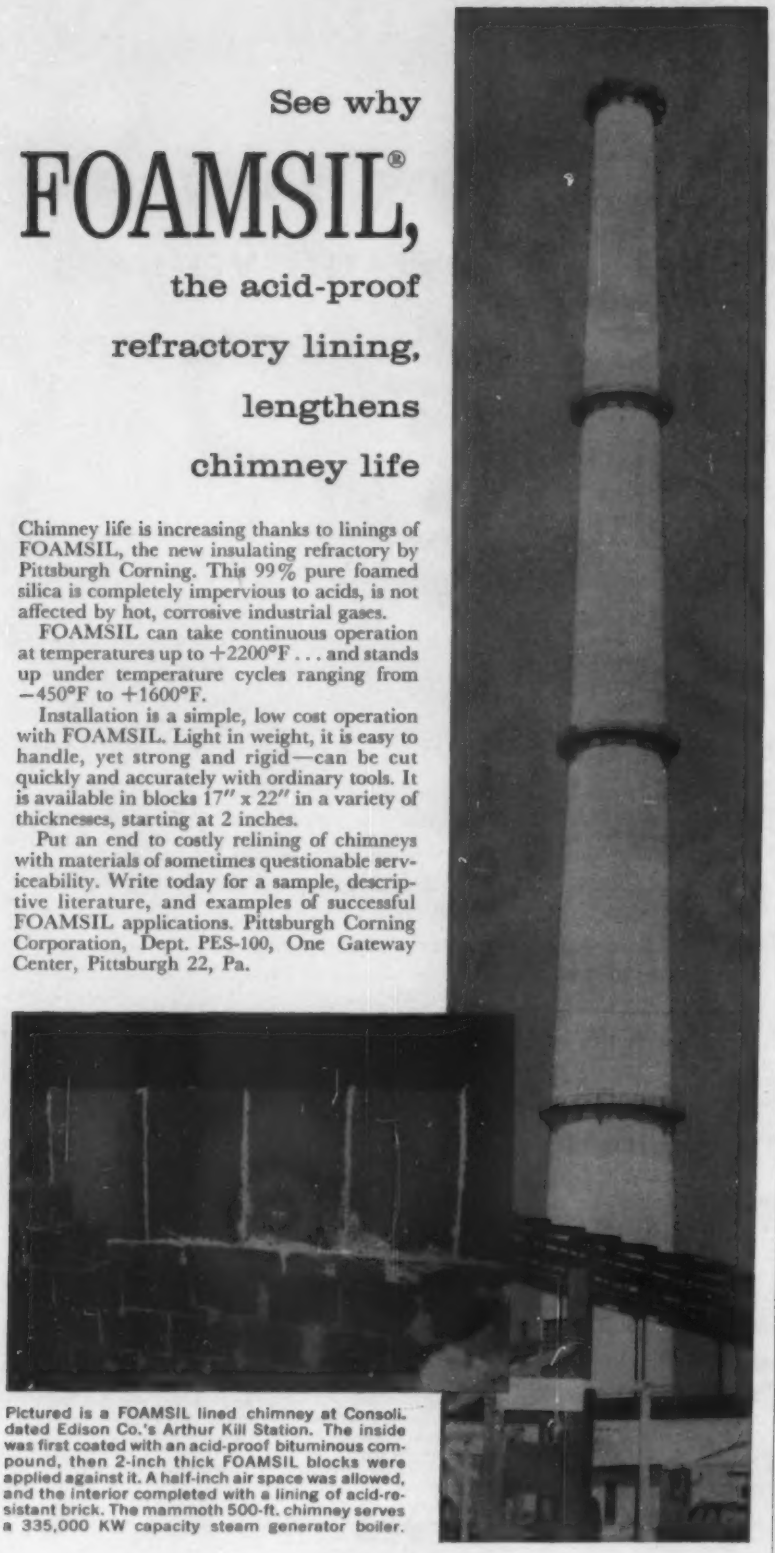
Put an end to costly relining of chimneys with materials of sometimes questionable serviceability. Write today for a sample, descriptive literature, and examples of successful FOAMSIL applications. Pittsburgh Corning Corporation, Dept. PES-100, One Gateway Center, Pittsburgh 22, Pa.



Pictured is a FOAMSIL lined chimney at Consolidated Edison Co.'s Arthur Kill Station. The inside was first coated with an acid-proof bituminous compound, then 2-inch thick FOAMSIL blocks were applied against it. A half-inch air space was allowed, and the interior completed with a lining of acid-resistant brick. The mammoth 500-ft. chimney serves a 335,000 KW capacity steam generator boiler.

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build about 430 miles of large-diameter pipeline; about 2178 miles of branch lines; 57,400 hp in additional compressor capacity; and 303 town border stations. It was expected that 342 communities would be served in Minnesota, Iowa, Wisconsin, South Dakota, Nebraska, and Illinois.

Subsequently, Northern stated it would not be serving 46 of the communities for which service was originally authorized. The adjustment reduces the over-all cost of the project from $114,618,000 to $101,469,000.

» **Plains Electric** Generation and Transmission Coöperative, Inc, of Albuquerque, N. M., has filed an application with the FPC for a preliminary permit on a proposed hydroelectric project on the Rio Grande and Red rivers near Questa, N. M.

Under the preliminary plan of development, water would be pumped 350 ft to the top of the bluff at the Chiflo dam site on the Rio Grande and then transported by canal 6.5 miles downstream to a reservoir at a point above the powerhouse site at the confluence of the Rio Grande and Red rivers. Water would also be pumped from the Red River at a point about four miles upstream from the power plant, to the top of the bluff, and then transported by canal to the upper reservoir.

Regulating dam below the powerhouse would be built to keep flows in the Rio Grande unaffected. Retention dams with small storage capacities would be built at both pumping locations.

Proposed initial installed capacity: 20,000 kw. Cost: $6,507,000.

» **Washington** Public Power Supply System, of Kennewick, Wash., has filed an amended application for its proposed Nez Perce hydroelectric project on the Snake River in Idaho and Oregon.

Application makes several changes in the proposed project, including substantial increases in the installed capacity and estimated cost. The original application has been consolidated for hearing with a conflicting application previously filed by Pacific Northwest Power Co, which seeks a license for its proposed High Mountain Sheep hydroelectric development in the same stretch of the Snake River.

As now proposed, Washington Public Power would build a 700-ft-high dam on the Snake River about 2½ miles below the mouth of the Salmon River. Initial installed capacity would be 1,995,000 kw, with an ultimate 3,192,000-kw capacity. Total esti-

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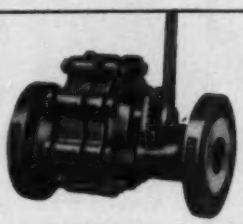

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mated cost is $412,000,000, including $61,500,000 in net interest during construction.

» **FPC announced** a proposed general revision of its uniform systems of accounts applicable to Class C and Class D public utilities and licensees.

Proposed revised accounts would apply to smaller electric utilities and holders of FPC licenses for hydroelectric projects.

The rule-making notices, together with the complete proposed texts of the Uniform Systems of Accounts applicable to Class C and Class D public utilities and licensees have been published in Part II of the Federal Register. Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 15 cents each.

FPC on June 7 issued a general revision of its system of accounts applicable to the larger electric utilities and licensees (Class A, Class B).

» **Approximately** 92 per cent of the major privately owned electric utilities in the U. S. were using the straight-line method of depreciation in their accounting at the end of 1958, indicating a continuation of the trend toward its general adoption, a report prepared by the FPC shows.

The straight-line method apportions depreciation expense in equal amounts over the estimated useful life of the plant. The interest methods also seek to recover the cost of depreciating property by the end of its useful life. In the retirement method, credits to reserves are based largely on an assumed uniform rate of property replacement, with adjustments for any variations. Under the revenue method, the credit is a fixed percentage of revenues, usually reduced by the amount spent for maintenance of the properties.

A 10-page paperbound report, entitled "Electric Utility Depreciation Practices, 1958," can be obtained for 15 cents from the Superintendent of Documents.

» **Northern Natural Gas Co,** Omaha, Nebr., has been authorized by FPC to construct and operate natural gas pipeline facilities in Ochiltree and Hansford counties, Texas.

Northern will build a 7000-hp compressor station; about 40.8 miles of varying diameter gathering lines; and an additional 50,000,000 cu ft per day in dehydration capacity, with an additional 100,000,000 cu ft per day in hydrocarbon extraction capacity at its Spearman plant. Cost will run approximately $5,311,125.

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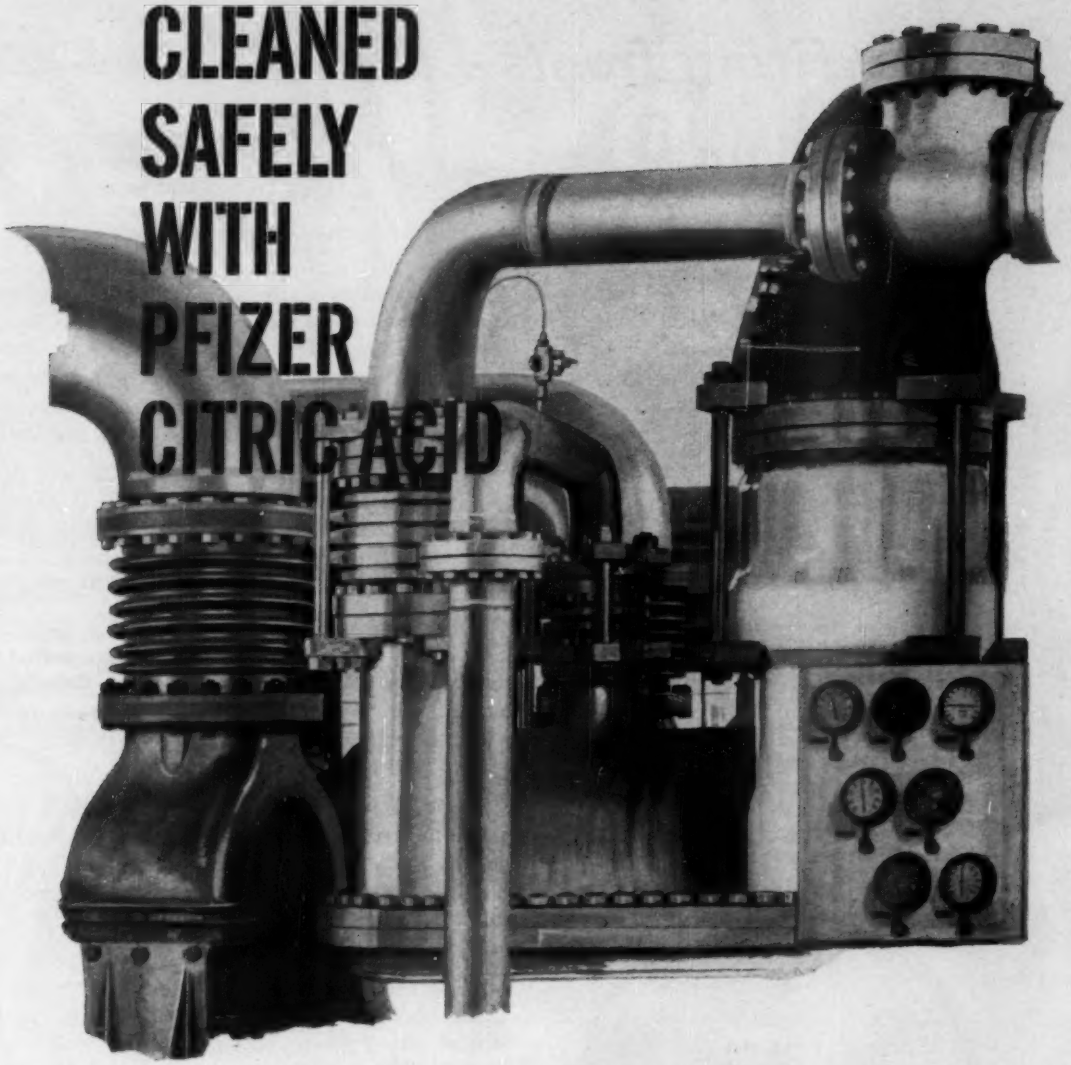

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automatic firing fronts.....

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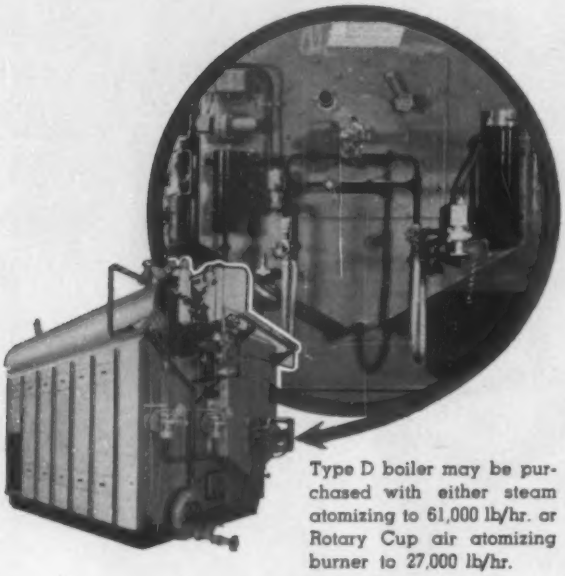

Type D boiler may be purchased with either steam atomizing to 61,000 lb/hr. or Rotary Cup air atomizing burner to 27,000 lb/hr.

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The efficient firing front of a Superior Package Boiler is much more than a mere burner . . . it is an integrated burner with its associated controls combined with an air register designed to provide proper velocities and turbulence as well as an air-cooled firing front which is both accessible and uncluttered.

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Burner equipment is dictated by your operations. *Single steam atomizing burners* are provided for capacities to 46,000 lbs/hr. with positioning or metering controls. For greater capacities, twin burners with metering controls provide an extended range of operation with greater safety.

The steam atomizing burner illustrated, shows shut-off valves, recirculation feed control, fuel temperature control and atomizing steam qualifier . . . neatly assembled at firing front for maximum performance, safety and availability.

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The rotary burner illustrated is mounted on a forced-draft windbox with triple channel air supply, has self-contained atomizing air fan and automatic fuel temperature control. This arrangement provides maximum flexibility combined with economy and safety of operation.

Their unique firing fronts are but one of the many exclusive features which make Superior Packaged Boilers outstanding in their field. If you'd contemplate the purchase of a boiler, it will pay you to investigate. Write for Catalog ASD-12.

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Current Catalogs

continued from page 32

tains selection data on 35- and 45-deg deep trough idlers designed for handling such heavy materials as coal, sand, gravel, crushed stone and crushed ores.

154 Feeders, Rotary Valves — Eight-pp Bulletin F-5A illustrates and describes Fuller Co.'s roll and vane-type feeders and rotary valves for dry pulverized and granular materials. Photos and drawings illustrate details and tables list dimension and capacity figures.

155 Vibrating Feeders — Illustrated and described by Link-Belt Co. in 6-pp Folder 2770 are vibrating feeders which incorporate a new principle of vibration for high-capacity, controlled feeding of heavy and highly abrasive bulk materials.

156 Elevator Rope — Advantages of Macwhyte Wire Rope Co.'s elevator cables are detailed in 12-pp Catalog E-10-2, which also gives practical selection information, safety factors and tips on lubrication, inspection and maintenance. Specifically, this booklet tells how to determine lubrication of elevator rope, when to retire it, how to guard against unusual tension and how to socket elevator rope. Compares six and eight-strand ropes. Lists elevator ropes suited for twelve common types of installations.

Other Equipment

157 Crushing Handbook — This 40-pp Handbook of Crushing by Pennsylvania Crusher Div., Bath Iron Works Corp., covers the subject of mechanical size reduction, describing various reduction methods — impact, attrition, shear and pressure — and many kinds of crushing equipment. Illustrated with diagrams and charts, it contains data on closed circuit crushing systems, factors in selecting crushing methods for particular applications and materials.

158 Product Guide — Information on a variety of products — including expansion joints, plastic products and cryogenic systems — manufactured by Uni-Flex is presented in this 10-pp bulletin. Techniques in expansion joint fabrication and applications are covered.

159 Aluminum Jacketing — Bulletin ICB describes Insul-Coustic Corp.'s aluminum jacketing for insulation protection. Applications and installation details are covered and photos of typical installations included.

Postage-free cards for ordering catalogs are on this page. You may also use the cards to order literature mentioned in the ads.

160 For Submerged Pumping — Described in 6-pp Bulletin F-1976 of U. S. Electrical Motors Inc. are motors for low head submerged pumping. Design features are detailed and operating advantages, dimensional data and ratings covered.

161 Back-Up Rings — In Catalog 5482, 8-pp, Parker Seal Co. shows how to

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increase O-ring life — seal higher pressures, reduce costs — with use of the contoured and continuous back-up ring, Parbak. It includes design data, sizes, dimensions and compound information.

162 Solutions to Corrosion Problems — Polyvinyl chloride, polyethylene and polypropylene exhaust systems are detailed from design to completion in this bulletin prepared by Industrial Fabricators, Inc. Systems provide corrosion resistance for all fume handling problems. Installation data sheets included.

163 Project Engineering Services — In 12-pp Bulletin 8010, Dorr-Oliver, Inc., describes engineering services in the development of complete plants on a world-wide basis. Services covered include laboratory testing, pilot plant demonstration, flowsheet preparation and engineering studies, cost estimates, plant design and specifications, purchase of equipment, erection and construction, supervision of initial operation, and training of personnel.

164 Light and Air Diffusers — Detailed information on combination light and air diffusers is contained in 24-pp Catalog F 9768 released by Day-Brite Lighting, Inc. and Barber-Colman Co. Data for selecting and predicting performance, and drawings illustrating how the light and air diffusers are installed and balanced are included.

165 Supplies and Equipment — Air conditioning, ventilation, refrigeration and heating supplies and equipment are listed in this 40-pp 1960 Estimating Guide supplied by Blaser Corp. Quick selection of blower units, fans, coils, cooling towers, evaporative condensers, valves, fittings, etc. is made possible by graphic illustrations and quick selection tables, accompanied by pricing tables. Blaser Corp.

166 On Solid Lubricants — Theory and practice of lubrication by solids are primary subjects of 24-pp Bulletin 124 of Alpha-Molykote Corp. Discusses major advantages of molybdenum disulfide solid lubricants — low coefficient of friction, natural affinity for adherence to metal surfaces, pressure resistance beyond yield point of metals. Booklet explains how molecular structure of MS_2 accounts for its function as a lubricant. Also describes company's research facilities.

167 Washable Tracings — Described in this bulletin issued by Keuffel & Esser Co. is a process of restoring the printability of original tracings simply by washing them with soap and water. Included is a sample of Herculene drafting film and a pencil which puts down a waterproof plastic line.

168 For Process Industries — Twelve-pp Bulletin G-3D, Fuller Co., describes equipment for process industries. Discusses applications and performance characteristics of pumps, pneumatic conveyors, fluidizing conveyors, rotary compressors and vacuum pumps, horizontal-grate coolers, suspension-type preheaters, positive displacement blowers and gas pumps, and induced draft fans. Operating principles are explained and installations illustrated.

169 Be Your Own Weatherman — This 16-pp booklet issued by Ilg Electric Ventilating Co. gives some interesting tips on weather forecasting to help you be your own weatherman. Also describes some simple do-it-yourself tests to make to assure safe and satisfactory ventilation.

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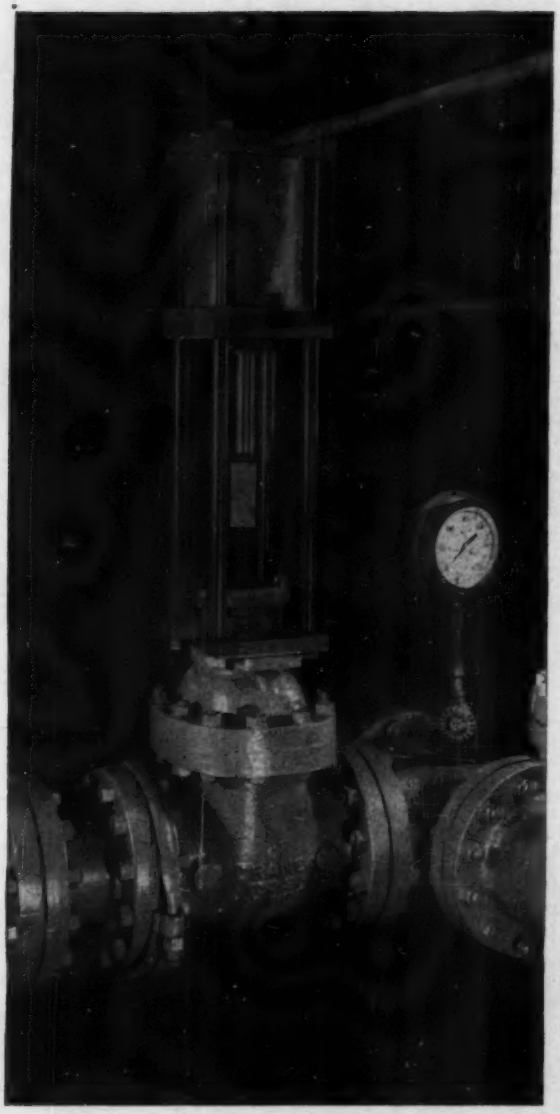
NEW CRANE CYLINDER OPERATORS— LOW-COST POWER OPERATION FOR GATE VALVES



Now you can control any flow process easier and faster with cylinder operated Crane valves. Large valves . . . valves in remote or inaccessible locations . . . valves that must be cycled many times a day . . . all these can now be operated at the touch of a finger, saving time and manpower. These benefits of power operation are available from Crane now—at lower cost and in less time than ever before!

Crane cylinder operators are available for Crane O. S. & Y. iron body wedge and double-disc gate valves, and for pulp stock valves. Control devices for local or remote actuation supplied at extra cost.

And you can get these new operators for modernization of your present Crane gate valves, too. Easy-to-install adapter is shipped with every cylinder. Field installation can be done in 30 minutes or less, without removing the valve from the line.

This new valve operator is another example of how Crane solves your flow problems more economically, more productively. The Crane solution —the right answer to your flow problems—is as close as a phone call to your Crane distributor. Call him today.

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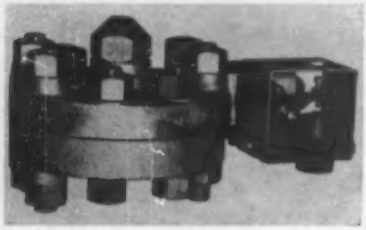
Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 114–115 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—Pilot valve operates on liquid level differential

Variable system pressures do not affect the function of this differential-level pilot valve, announces Besler Corp. The valve operates on the difference between two columns of liquid, usually between a constant reference head and a variable



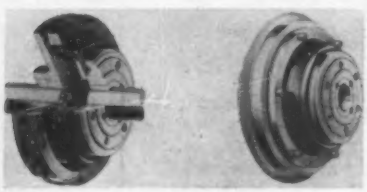
head. As level rises in variable column the valve opens and releases air pressure from the top of a diaphragm motor, allowing discharge of liquid from variable column. When level in this column falls to a pre-determined level the valve again closes, and cycle repeats. Principle can also be used with a steam trap to operate over a wide range of pressures.

2—Tri-color annunciator uses colors to show condition

Nameplate of the annunciator, manufactured by Electro Devices Inc., displays bright white on alarm, red after acknowledgement of alarm, green when trouble contact returns to normal, and back to normal dim or dark, as desired, when return to normal is acknowledged by operator. Dim indication is used to monitor lamp continuity without requiring periodic testing by operator. Longer lamp life is claimed.

3—Flexible couplings for high speed, high torque applications

Para-flex High Speed and Para-flex Flywheel Couplings feature a pen-shaped rubber flexing element. Produced by Dodge Mfg. Corp., they are designed to operate at higher speeds and transmit greater torque than the original Para-flex Couplings (which have a tire-shaped flexing member of cord and rubber construction) and to extend the practical applications of Para-flex. Like the standard units, both new types are designed to accommodate angular and parallel shaft misalignment and end float, to absorb torsional vibration, and to cushion shock loads as well.



In the High Speed Para-flex, the flexible member is supported on one side by a clamp-ring flange; the larger side is bolted to a steel disc. Both flange and disc have Taper-Lock bushings for easy mounting on shafts. For speeds up to 5230 rpm, this coupling may be used with electric motors or internal combustion engines to operate hammer mills, compressors, pumps, high speed fans, blowers and is claimed by Dodge Mfg. Corp. equally efficient on low-speed applications with high torque needs.

The Flywheel Para-flex is similar, except that its larger side bolts directly to the flywheel of an internal combustion engine. It comes in sizes to fit bolt circles of most standard SAE flywheels up to 19¼ in. diam. Flexing members of both new types absorb noise-producing vibrations and serve to prevent flow of electrical current between shafts — there is no metal-to-metal contact and no lubrication is required. The new couplings come in sizes to deliver up to 47 hp per 100 rpm, to fit shafts up to 4 in. diam.

4—Electronic ferret pinpoints cable insulation failures

This subterranean sleuth seeks out underground cable insulation failures before they happen. As explained by manufacturer, Sorensen & Co., the cable tester discovers a poor insulation and then electronically "breaks through" the fault, burns out the future failure to prevent "healing" and keeps firing high power pulses of current into the fault so that its precise location may be traced and repaired. A tracer, incorporated in the tester, darts through the cable and finds the fault detected by the tester circuit. The tester applies voltage to the cable's conductor and any current leaking through the insulation is measured, indicating condition of the cable and setting the tracer to work. This tracing method may also be used to identify cables for safer working conditions, to determine correct phase relationship in multi-phase systems and to examine current flow.

5—Double pipe heat exchangers for high capacities

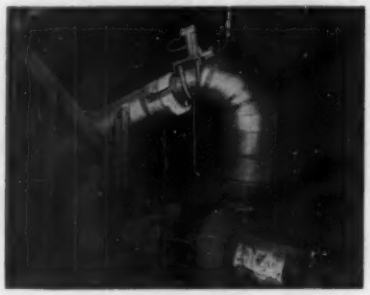
These multi-tube double pipe heat exchangers are designed by Brown Fintube Co. to permit double pipe units with advantages of standardization to be used in high capacity applications. This, company notes, has previously been economically unfeasible due to number of units required. By engineering a bundle of finned tubes to one individual section, company has increased capacity of a single hairpin so that high capacity applications are met. Benefits of maintenance, operation, and standardization are announced, for all heat transfer duties in a given plant can often be met by combining numbers of the basic section into the proper arrangement of series-parallel.

6—Compact toggle switch keeps tabs on positions

Requiring about 1 in. of space behind control panels and weighing 1/14 oz, the 400 series of toggle switches introduced by Micro Switch, Div., Minneapolis-Honeywell Regulator Co., features bright aluminum tabs to provide instant position indication. Switches are available in both momentary and maintained-contact versions, for use in electronic equipment, data processing systems, industrial consoles and other areas. Each toggle operates snap-action switches encased in a dust-tight plastic cover, and each switch has isolated single-pole double-throw, 5 amp, 125 or 250 v.

7—Pneumatic vibrator keeps material moving in pipes

The NAVCO BH-2 Air Vibrator, supplied with a bracket and U-boats for mounting on 4-, 6- or 8-in. standard pipe, is designed by National Air Vibra-



tor Co. to keep wet, moist material moving through all types of piping arrangements. Powdered coal, carbon black, ores and fly ash are dislodged by the timed piston impact, company says. One-piece design eliminates body assembly bolts, and reduces maintenance downtime. Manufacturer says these vibrators can be used in hazardous atmosphere, under extreme moisture conditions, on outside applications or with magnetic dusts.

8—Epoxy pipe coating has fast curing rate

Dearclad 765 is an epoxy pipe coating with rapid curing rate, exceptional resistance to physical impact, abrasion and moisture absorption, Dearborn Chemical Co. states; it protects against chemical attack, has high electrical resistance, and retains its physical properties from −40 to 250 F. Composed of two components for blending at the point of application, Dearclad 765 can be applied with brush, roller, or airless-type spray equipment.

When properly cured, the coating is said to withstand rough handling without damage. Pipe coated with it can be stored above ground in the sun or under

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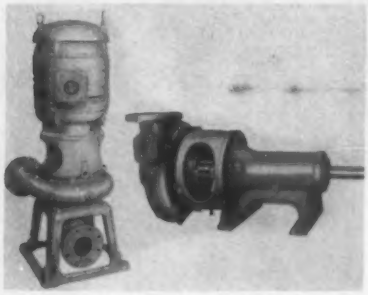
heavy pressure of piled pipe, it is noted. Underground, this coating serves to prevent damage due to soil stress and the dead load pressure or rocky trench backfill. Company recommends it for mill or yard coating because of its ease of application, short curing time and sag resistance at high temperatures.

9—Centrifugal pumps are NEMA-matched with motors

Adapt-Able Centrifugal Pumps, designed by Fairbanks, Morse & Co. to furnish a wider range of clear water, non-clog and other liquid modifications, are NEMA-matched; that is, pump



dimensions align with those of NEMA-rated motors for ease of mounting and trouble-free operation. They are constructed so that pump frames receive various size volutes and impellers. Design permits most economical frame size to be selected to match motor horsepower requirements of pumping job. Adapt-Ables are available in horizontal and vertical pump and motor units as well as "biltogether" construction.

10—Corrosion-inhibiting compound for freeze proofing coal

Hardy Frez-Pruf Compound is introduced to prevent coal from freezing while in transit or storage. Claimed effective and economical, the compound contains a phosphate additive which adheres to metal surfaces to provide protection against oxidation and electrochemical corrosion. Formulations for either dry or liquid application are available from Hardy Salt Co.

11—High temperature additive for lubricating oils, greases

Introduced for combatting high temperature deterioration of lubricating oil and reducing bearing corrosion, UOP-225 is described by Universal Oil Products Co. as an additive containing neither metal nor phosphorous. It is stable above 500 F and leaves no combustion ash, says manufacturer, and is soluble in petroleum and synthetic lubricants. First applications are expected to be in heavy duty greases, with recommended dosage of 1 to 2 per cent for diabasic acid or polyol derived lubricants to meet MIL-L-9236A specifications and ½ to 1 per cent for MIL-L-7807 oils. Advantages cited include corrosion protection for all bearing metals plus titanium, aluminum and magnesium. The inhibitor is compatible with common lube and transmission oil detergents and is also suitable for diesel, industrial and electrical transformer oils, it is announced. It is claimed insoluble in water, suggesting use for steam turbine lubricants.

12—Deep trough idlers for heavy, light materials

Additions to Link-Belt Co.'s line of 35- and 45-deg deep trough belt conveyor idlers offer possibilities for economical handling of materials that formerly required 20-deg idlers, due to their greater capacity. With the 35-deg idlers (shown), such heavy materials as coal, sand, gravel, crushed stone and ores can be handled, company says, while the 45-deg idlers are designed to handle lighter materials such as grain and wood chips, but under certain conditions can be applied for heavier materials. Book 2716A describes these idlers.

13—Speed reducers take up less floor space

These spiral bevel speed reducers of Hewitt-Robins, Inc., have a right-angle shaft arrangement which makes it possible to place the prime mover alongside driven equipment, resulting in important savings in floor space compared with parallel or concentric shaft reducers. The use of bevel gear drives makes it possible to reduce the size of the motor, controls and other accessories in many applications, manufacturer states. Energy loss for a single reduction spiral bevel reducer is reportedly approximately 2 per cent; for a double reduction, 3 per cent; and for a triple reduction, 4 per cent.

14—Automatic drain trap with greater discharge capacity

For use on compressed air lines to machines and air equipment, this small trap is designed to automatically discharge condensate and oil as it is collected. According to manufacturer, Perfecting Service Co., its larger size orifice has

increased the discharge capacity by 350 per cent, permitting a discharge rate of 60 gph. A blow-off valve is provided for periodic removal of accumulated rust and residue. Orifice and valve seat are self cleaning. The trap is only 7 in. high, has an overall diameter of 4⅝ in., weighs only 2 lb. Body and bowl are aluminum; valve mechanism is stainless steel and brass. Trap is available from stock in ¼ in. NPT. Bulletin 80 describes it in more detail.

15—High-temp insulation for fireproofing walls, etc.

Calsilite-Hi, a thermal insulation that withstands soaking heat up to 1800 F indefinitely and has the advantage of being an industrial fireproofing material is announced by The Ruberoid Co. It is effective for insulation of piping and equipment in plants, and for fireproofing walls, partitions and ceilings in refineries and chemical processing plants. Calsilite-Hi is a calcium silicate compound combined with asbestos fibres and others. Available in half-sectional, three segmental and block forms, it keeps its strength when wet, returns to its original thermal efficiency when dry, company states, and resists most chemicals and alkalis in industrial concentrations.

16—Return system deaerates make-up and condensate

Elimination of condensate flash loss — which in high pressure processes can amount to 15 per cent of feedwater requirement — is claimed for this high temperature return system of H T Boiler Feeder Co. In addition, the preheating of make-up and condensate in reservoir tank deaerates boiler feedwater to well below the 0.03 cc per liter

standard required to control oxygen corrosion of boiler surfaces. Basically, the boiler feeder is a gravity flow system, utilizing three tanks — a condensate tank, C, which receives make-up water from fresh water supply, and condensate from heating or process steam lines; Tank P which feeds water to boiler by alternately producing vacuum and pressure; and a reserve tank, R, which provides a reservoir of continuously heated feedwater for boiler. Equalized pressure allows water to flow by gravity to boiler from Tank R. Tank C may be vented to atmosphere or equipped with an air vent type steam trap.

17—Dye-penetrant system detects surface flaws

Pixchek is introduced by Picker X-Ray Corp., as an effective and economical means of finding defects in exteriors and open sub-surfaces of metals, ceramics, glass and most plastics. This dye-penetrant system is available in a compact kit containing both spray and liquid cans for on-the-spot inspection. It also comes in bulk. Unseen flaws are

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AVAILABLE HELP FOR PLANT PROBLEMS

Many outstanding articles published in Plant Engineering and Power Engineering have been reprinted to assist you in your everyday job problems. Following is a list of the available reprints with prices. Look this list over, decide which ones you want, fill in the coupon at the bottom of the page and send it to us with your check or money order.

Some of these reprints are in comparatively short supply so get your order in early.

Which one (ones) will serve you best?

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1	Atomics—48-page booklet of material which has been appearing in Power Engineering on atomic energy development throughout the world.	$1.00
2	Industrial Lighting—12-page manual covers lighting factors a plant engineer should consider. Discusses voltages, costs, etc.	0.50
3	Fluid Power Maintenance—48-page booklet on the selection, installation and maintenance of the various components of pneumatic-hydraulic systems.	0.75
4	Construction Cost Estimating—32-page, two color reprint of the time-savers series of articles recently appearing in Plant Engineering, covering all phases of estimating industrial construction costs—from floor slab to roof.	1.50
5	Effective Start-Up Engineer Smooths Out Preliminary Power Plant Operation—16-page reprint covers effective scheduling of start-up, checking of condensate, boiler feed and circulating water systems.	1.00
6	Construction Specifications—20-page reprint of five-part article on construction specs. Discusses what should be included in specs; payments, arbitration; construction bids; signing contract; progress report and final inspection. A copy of "General Conditions" will accompany the reprint.	2.00
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How to return condensate a full mile at 280° F.

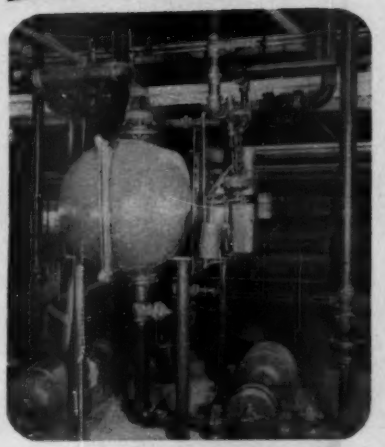

Photo courtesy of A. M. Byers Co., suppliers of the 4-D Wrought Iron pipe used on the return lines.

This is one of 11 Stickle differential boiler return systems at General Electric's famous Appliance Park in Louisville. For seven years, it's been pumping condensate back to a receiver tank in the boiler room at 270° to 280° F.—from heating and processing units as far as a mile away! The two pumps handle up to 150,000 lbs. of condensate per hour. Result: Tremendous savings in fuel and steam, plus top performance by all steam-using equipment.

If you use steam for processing or heating at pressures between 50 and 250 lbs., check with us. We can show you 8 ways to cut the cost of steam, increase production and improve quality . . . with a Stickle boiler return system.

• ASK FOR BULLETIN 250

STICKLE STEAM SPECIALTIES CO.
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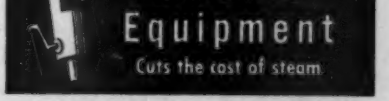

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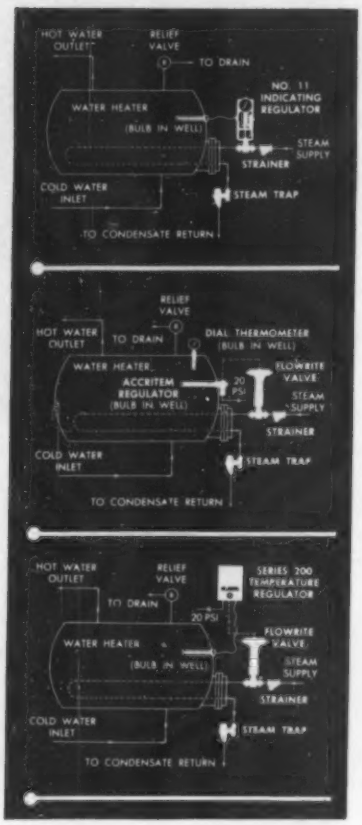
Practical Ways To Control Hot Water Storage Heaters



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Specific requirement or problem:

These diagrams, plus clear and concise information on storage heater control, are available to you without obligation as part of the Powers *Engineer's Manual, Steam-Water Service.*

This manual has been specially prepared for plant use. It is available free to personnel whose job function covers operation and/or installation of steam-water service. Various control systems described and illustrated include: domestic hot water . . . instantaneous heat exchangers . . . heat exchangers for cooling . . . fuel oil heaters . . . pressure reducing . . . jacket water cooling . . . two-temperature hot water systems.

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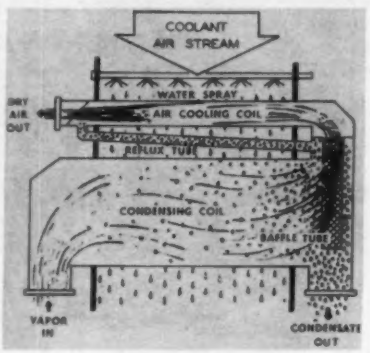
made visible with Pixchek by action of a chalk-white developer on a low-viscosity red dye. The dye penetrant is drawn up by the developer from the defect to make a red stain pattern on a white surface. Interpretation of this "blood stain" pattern reveals type of flaw.

18—Vapor condenser cools by evaporative principle

Cooling is achieved in this high capacity vapor condenser by the evaporation of moisture on tube surfaces through which vapor passes. According to manufacturer, Niagara Blower Co., capacities of 30 million Btu are available from single



units. Heat given off from vapor as it is condensed is transferred to air stream and rejected into atmosphere. Noncondensibles are sub-cooled several degrees and separated from condensate by steam ejector or vacuum pump, and condensate is kept in a closed system under high vacuum. Dampers regulate capacity and automatically vary amount of air handled in proportion to load, removing heat at rate of input and controlling temperatures.

19—Control panel regulates up to five compressors

Introduced by Clark Bros. Co. to serve as a single control point for as many as five electric motor driven compressors, automatic control panel is designed to keep in operation only those machines required for the immediate demands of process air or gas; to permit manual or automatic control of any or all compressors start up and shut down in accordance with a sequence set by manually operated base unit selector. No two machines can start at the same time, company says, and each preceding machine must be running before the next unit can start. By alternate selection of base unit, even wear is distributed over all compressors in system, and what would normally be the Number One compressor is relieved of continuous duty.

20—Convertible valve reduces inventory, spare parts

The P-K Paul Valve of General Kinetics Corp. can be converted from a manual valve to a control valve or a motor operated on-off valve, it is announced. Conversion of this Venturi-ball design valve is made by replacing the bonnet and stem of the manual valve with a new bonnet and stem and a yoke carrying the required topworks. With this valve, for example, a chemical processor

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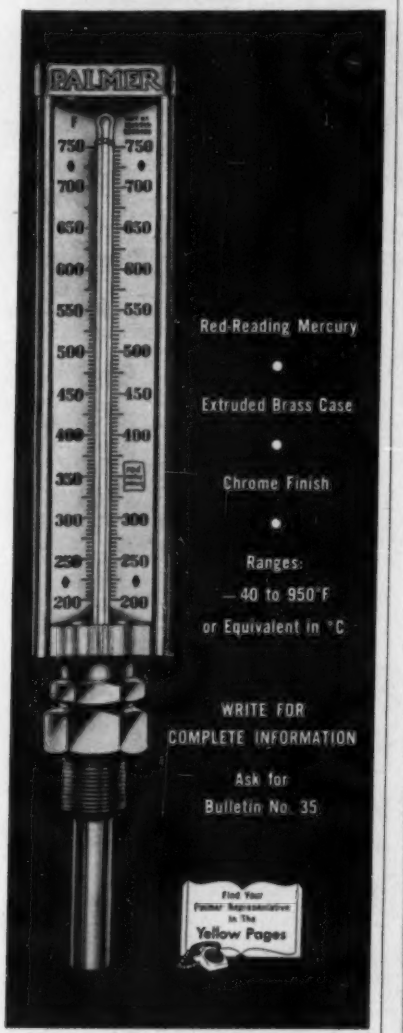
RED-READING MERCURY THERMOMETERS



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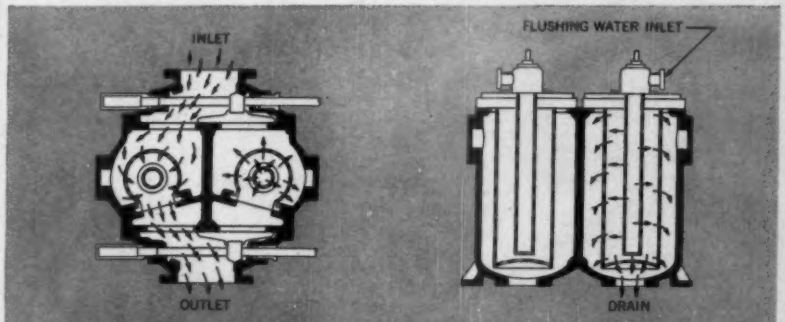
Elliott motorized back-flushing twin strainers

FOR HEAVY-DUTY
INDUSTRIAL SERVICE

● This Elliott type A Twin Strainer is built to handle 2000 gpm of river water ● provides continuous flow of clean water for New Jersey industrial plant ● geared electric motors shift the valve discs and operate the rotary spray pipes ● this design is capable of handling extremely bad water ● one basket is automatically cleaned while water flows through the other basket, assuring continuous service.



Geared electric motor shifts the valves, sealing off one basket for back-flushing, while uninterrupted water flow passes through the other basket.

Geared electric motors revolve spray pipe sending jets of flushing water against inside of basket, removing accumulated debris, which is flushed out the drain.

AO-2

Contact your nearby Elliott District Office or write Elliott Company, Strainer Department, Jeannette, Pa., for complete descriptive details.

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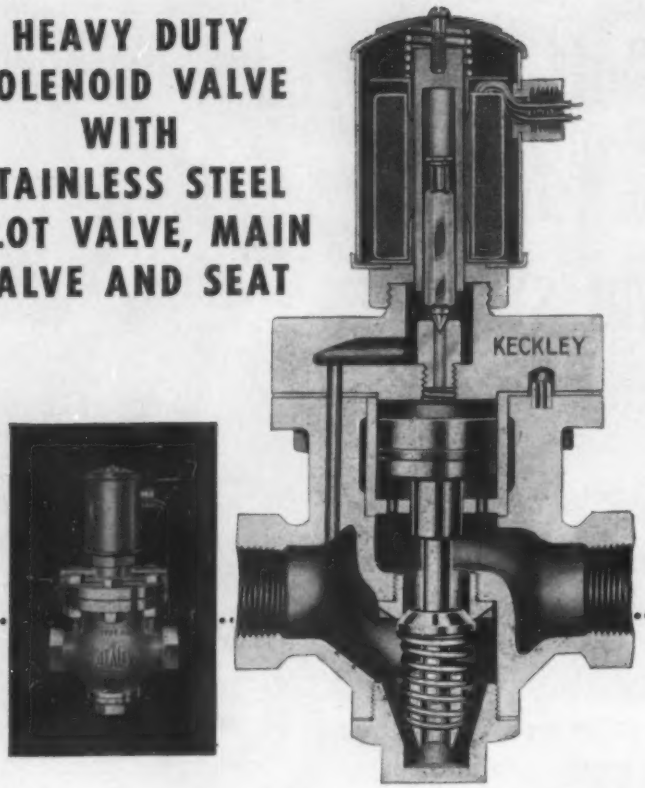
HEAVY DUTY SOLENOID VALVE WITH STAINLESS STEEL PILOT VALVE, MAIN VALVE AND SEAT



• The heavy duty pilot operated Type EA Keckley Solenoid Valve has many features not found in all solenoid valves. Simplicity of design has eliminated many wearing parts, and parts subject to wear are renewable. The piston is located above the flow eliminating any possibility of sediment scoring the cylinder liner. Valve body assembly is the same as Keckley Pressure Regulators of equal size—parts are interchangeable.

Incorporated into these valves are the best of materials and workmanship.

Order one for a test in your plant—no obligation. Write for details—Catalog 58-A.

SPECIFICATIONS

TYPE EA SOLENOID VALVES

Maximum Steam Pressure—250 lbs.
Maximum Air, Water, Oil and Gas Pressure—600 lbs.
Sizes ½" to 6" with Bronze or Semi-steel Bodies
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Cylinder Wall—Bronze or Monel
Coils—Heavy Duty, Glass Insulated, Moisture Proof

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can upgrade dead-end service valves and use them for critical temperature and pressure operations. The valve comes in four sizes from ¼ to ¾ in., with pressure ratings of 1500 and 2500 lb. Standard construction for the manual valve is with inside screw. Automatically operated valves have interchangeable outside screw and yoke construction.

21—Purge meter designed to withstand high pressures

These armored purge meters, announced by Wallace & Tiernan Inc., are designed to withstand pressures to 1500 psi and temperatures to 400 F. They have a water capacity from 1.6 to 100 gph, and an air capacity from 7.5 to 420 scfh. Meters are claimed to give extremely stable indicating performance even at low gas pressures. A magnetic indicator travels on inside surface of the scale tube, rather than on the outside surface of the steel extension tube. This is said to reduce friction and give immediate response to varying flow rates. Scale tube is calibrated with both water and percentage scales, so it can be quickly rotated to percentage scale when flow is changed to fluids other than water. Catalog 510.200 gives details.

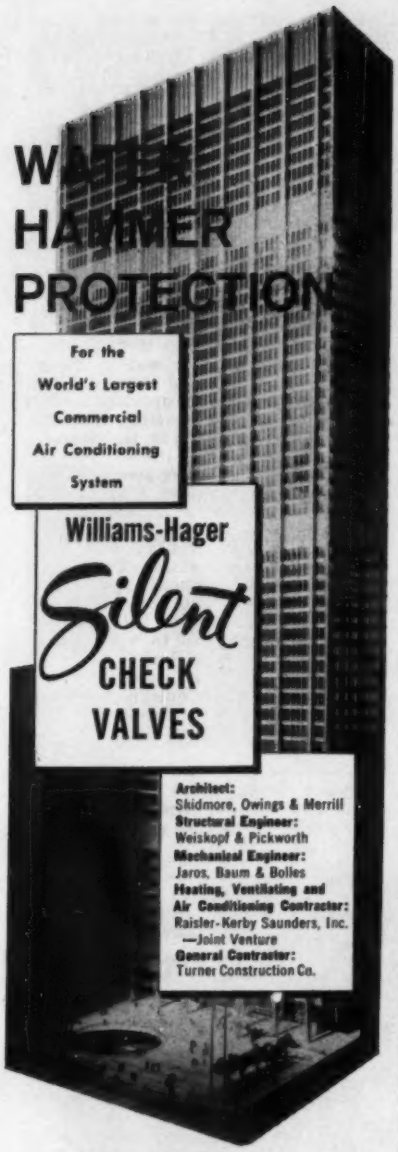
22—Insulating tape has smooth overlapping feature

CDF Level-Wrap Tapes, made by Continental-Diamond Fibre Corp., are self-adhering unsupported silicone rubber insulating tapes featuring triangular cross sections for smooth wrapping on

irregular shapes. Each tape is as thick at its apex as the required total insulating thickness. When wrapped in overlapping halves, the tapes give smooth, even external surfaces. A colored center line guides wrapping and overlapping. Tapes are available in eight standard grades from 1 to 1½ in. wide and from 0.020 to 0.080 in. thick at apex and 0.007 to 0.008 in. at edges, in 12-yd rolls.

23—Temperature indicator is portable, battery-powered

This 2-lb temperature indicator, Model 583, developed by Fenwal Inc., has thermistor sensing probes and batteries with an estimated life of several thou-



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building in New York, a magnificent new 60-story structure, *Silent Check Valves* reliably protect pumps and the piping system against surge pressures and resulting water hammer.

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sand hours. It is available in 10 ranges from −30 to 350 F, and uses interchangeable probes for air, liquid and surface temperature sensing. Instrument is designed for use in periodic checks of incoming water temperatures in utilities, in thermal pollution studies of rivers and streams, for periodic checks of processes and equipment, such as bearings, which are not constantly controlled or monitored, and for surveying plant thermal conditions for air conditioning or safety purposes.

24—Ductile iron pumps in single and multi-stage units

These horizontal split-case pumps are described as offering extreme thermal shock and corrosion resistance. They are produced for intermediate range service by Peerless Pump, Hydrodynamics Div., Food Machinery and Chemical Corp. They have a fluid temperature range of 350 F. Peerless Type A pump is a continuous duty, horizontal split case, single stage centrifugal pump. Manufacturer says it can be applied to the widest variety of pumping jobs handling water and other liquids, even when there is a modest amount of non-abrasive solids in suspension. It is available in sizes of 4 in. and larger, capacities to 60,000 gpm; heads to 400 ft. All types of drives are available.

The two-stage Peerless Type TU and the three-, four- or five-stage, Peerless Type TUT, are suggested for supplying, circulating and boosting water and process liquids. Heads to 1500 ft and capacities to 3000 gpm are handled, and all types of drives may be used. Bulletin B-1314 describes these ductile iron pumps in more detail.

25—Breakers offer protection with fewer frame sizes

This line of thermal-magnetic circuit breakers offers overload protection for the entire range of industrial applications with only six frame sizes instead of twelve, according to Westinghouse Electric Corp. Also, these breakers need less

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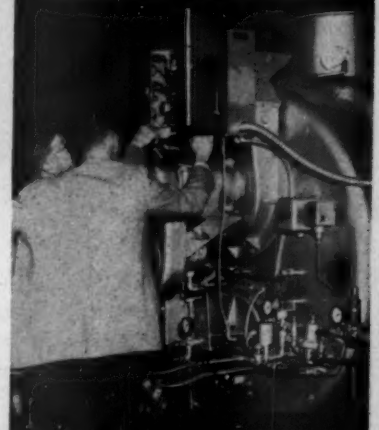

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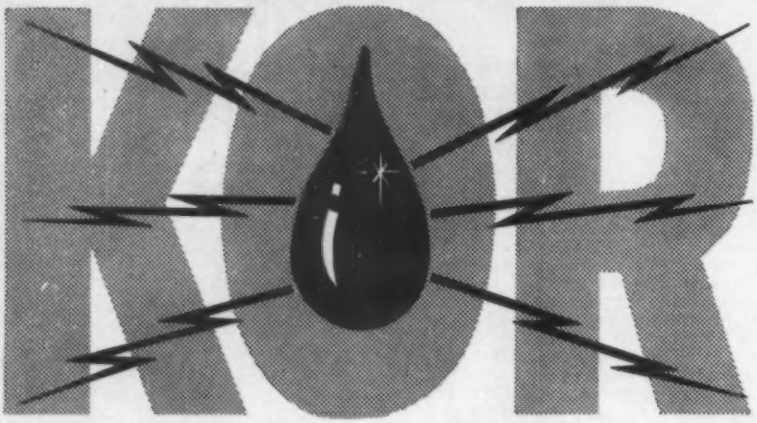

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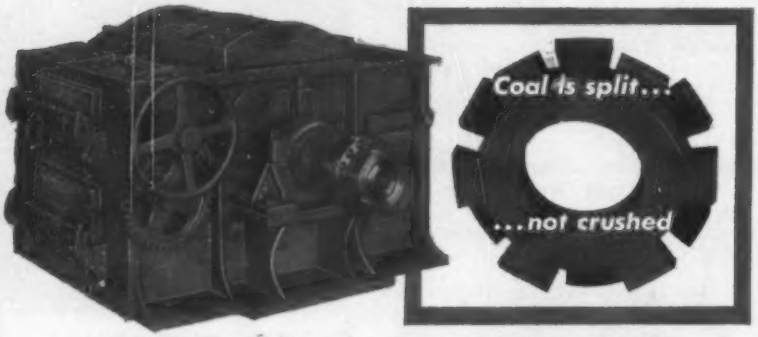

More than a half-century of experience has resulted in consistent improvement in American crushers, yet the rolling ring principle (patented in 1908) still remains the most efficient. Hundreds of "cost of operations" reports from American users prove this fact.

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space for installation. Several frame sizes of the old line have been replaced with a fewer number of newly designed frames having a wide range of ratings. Frame sizes are designated E, FA, JA, KA, LA and MA, with maximum current ratings from 10 to 800 amp, interrupting capacities from 5000 to 50,000 amp. Type KA (shown) can be used instead of the old JK and K frames, it is explained, but it is only 5½ in. wide and 10⅛ in. long, as compared to the 8¼-in. width of the JK and K, and the 15½-in. length of the Type K.

26—Dry lube stick for cutting tools, sliding surfaces

Molykote Lubricating Stick is an extreme-pressure molybdenum disulfide dry lubricant in stick form, resin bonded for greater strength. A product of The Alpha-Molykote Corp., it permits easy

application of a lubricating film to cutting and shaping tools, sliding areas of small and medium size machine parts, or wherever metallic dry friction occurs on sliding surfaces. To apply, just rub the stick over the cleaned surface. It is also suggested for small surfaces where oil cannot be used because of contamination, temperature restrictions. The stick can even be formed in desired size for use as an element in the bearings of small machines, ways and light equipment undergoing oscillating movements.

27—D-c power supplies are self-protecting units

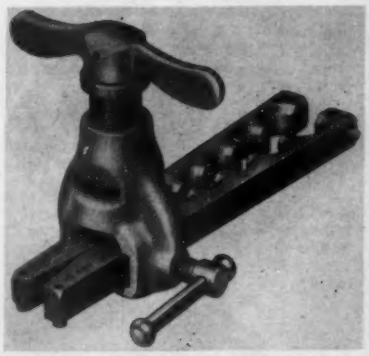
Convection cooling, self protection and fewer components are announced by General Electric Co. for this standard line of 30 precision-regulated transistorized d-c power supplies. Reduction of required components by about 25 per cent is attributed to improved circuitry and design. For static operation, the units feature convection cooling to reduce maintenance requirements and provide quieter operation with no difference

in noise level between on and off. Incorporation of a "constant watts" circuit serves to protect against overloads, short-circuits, misadjustments and high line voltages. This circuit measures both volts and current dissipated in the transistors. When an overload or fault occurs, the supply is automatically turned off, manufacturer states, and recovery is instantaneous with no reset required, since the circuit resets itself.

Elimination of variable auto-transformers and relays has reduced both weight and size of the units. Priced from $350 to $1100, they are designed for applications where there is a need for constant output regardless of demand on the power supply. The units consist of power transistors, silicon rectifiers, alumalytic capacitors and three printed circuit boards: two, which are interchangeable between units, and the new "constant watts" board, interchangeable with each rating. Units also include an ammeter and voltmeter, on/off switch, a-c pilot light, a-c fuse line and voltage adjustments. Output voltages range from 1.5 to 100 v.

28—Flaring tools produce 45- and 37-deg flares

Three flaring tools are announced by The Ridge Tool Co. as producing uniform 45- and 37-deg flares quickly on copper, aluminum and brass tubing. In these tools, all working parts are locked together so that they cannot become separated and lost, company states; and hinge and aligning pins lock yoke, die bars and tubing into alignment. Bottom of yoke automatically gages flares for length, and eccentrically mounted steel



flaring cone forms flares by rolling action. Flare wall thickness is controlled by an automatic feed release. Flare is burnished when feed screw is released.

29—Manhole conduit fittings are above-ground type

For above ground installation, Type EAM Manhole Condulets are announced by Crouse-Hinds Co. as explosion-proof, dust-ignition-proof and weather resistant. They provide a convenient means for splicing main feeder cable and making branch taps and are intended to replace conventional below-ground units. They afford easy inspection of connections at any time, as covers are readily removable. Also, interiors do not have to be filled with hot insulating and water-proofing compound, company notes. Type EAM, listed with and without terminal block, is suitable for up to 600 v. It has two 4-in. conduit openings

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0—150# water service lines. Simple and reliable. Drop-tight shutoff. Pratt quality throughout.

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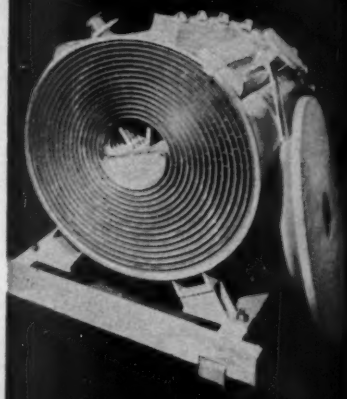

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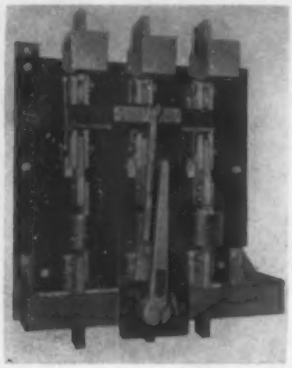
in the bottom, can be furnished with up to four 1¼-in. branch openings adjacent to main hubs.

30—Service entrance switch with improved features

Bolt-Loc Pressure Contact Switches, introduced by The Barkelew Electric Mfg. Co., can be furnished in 1200-, 1600-, 2000-amp capacities for 240, 480, 600 v a-c service. Two-, three- and four-pole switches are available, fused or



unfused, for front or rear connection. Bolt-Loc's pressure mechanism bolts the blades to the contacts when handle is moved to closed position, it is explained; arcing and pitting of main contacts are prevented by auxiliary springs which maintain an initial pressure when blades are opened or closed. Double-slot arc quenchers draw arc from arcing tips and divide, cool and extinguish it. Safety features announced include an interlock for fuse door to prevent switch from being closed with fuse door open and to prevent opening of door with switch on.

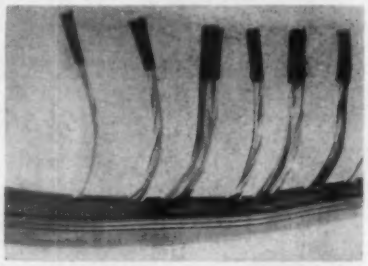
31—Intake units replace the air removed by exhaust

These steam-fired air intake units of Hartzell Propeller Fan Co. consist of a single cabinet housing a propeller fan and a steam coil. Four standard units provide a capacity range from 4000 to 36,000 cfm. Units can be installed with

or without filters and distribution ducts, according to requirements of installation. Shutters, filter house, filters, and outlet diffusers are available as accessory equipment. If tempered air is not required, heating coil can be omitted. Belt-drive duct fans, and vaneaxial and centrifugal blowers for external mounting can be supplied on order for use in high static applications or where other factors make internally-mounted, direct-connected fan impractical.

32—Tapered tubing for cables of decreasing diameters

Tapered Zippertubing offers a tight fitting jacket for cables of decreasing diam-

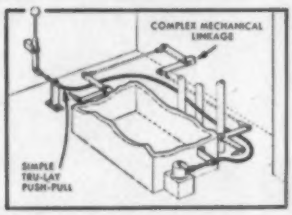


eters due to branch-outs. Wires can be pulled through perforations of this tubing to permit attachment to terminal points. One man can apply it, says The Zippertubing Co., and time and labor savings up to 50 per cent are possible.

33—Switchboard instruments offer accuracy, economy

Type A B Instruments are announced by General Electric Co. as a line of low-cost, 1 per cent accurate a-c voltmeters and ammeters. Element and case design utilized has permitted pricing them as much as 22 per cent below other models, according to manufacturer, while maintaining comparable quality, accuracy and durability. The line has the same 5.1-in. scale length as the rectangular switchboard instrument, Type AD-7, but its flange dimension is only 4¼ in. sq. The instrument has a 180-deg scale, normal rating of 5 amp. Voltmeter ratings are 150, 300, 500, 600 v.

TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

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HIGH PRESSURE VALVES
—USED—
EXCELLENT CONDITION

11 Crane motor operated gate valves 12", Limited Torque, Catalog 83½-U, Disc and Seat HF, Pressure 1000 lbs., Temperature 900°, Weld-On Type, Body WC 1S, Stem CR-13.

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THIS SELF-CONTAINED FLUID COOLING SYSTEM

...gives most accurate temperature control

Applied in cooling industrial machines or processes to temperatures approaching the ambient wet-bulb, the NIAGARA *Aero* HEAT EXCHANGER is independent of any more than a nominal water supply or disposal. The coolant system is a closed one, free from dirt and maintenance troubles.

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Niagara sectional construction saves you much installation and upkeep expense, gives full access to all interior parts and piping. Your equipment always gives you full capacity and "new plant" efficiency.

Write for Niagara Bulletin No. 132 for complete information

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The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 115–116.

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NOV. 28—DEC. 2, 1960

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METROPOLITAN EDISON uses...

ILLCO-WAY ion Xchange

This graphic control panel, designed and built by IWT, not only has all the controls but also a schematic diagram with indicating lights to show the action at all points.

Blowdown Unnecessary in a New High-Pressure Once-Through Boiler

The Portland Station of Metropolitan Edison Company at Portland, Pa., has a once-through type of boiler for which the purity of make-up water is particularly critical. IWT Mixed-Bed* De-Ionizers were selected to purify the make-up water to the required degree — and they succeeded, even beyond expectations. The total silica in the boiler water is consistently maintained at 0.1 ppm or less. From the Mixed-Bed* De-Ionizer, the silica is normally below 0.01 ppm and log sheets frequently show analyses as low as 0.003 and 0.005 ppm. With such a high purity of make-up water, blow-down is entirely unnecessary for extended periods of time. All IWT equipment — including chemical feeders, gravity filters, cation and anion exchangers, a vacuum degasifier, and the Mixed-Bed* De-Ionizers — are controlled *automatically* from the graphic panel shown above.

* U.S. Pat. Nos. 2,605,084, 2,771,424

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Such outstanding performance is the result of intensive early and continuing experience, by Illinois Water Treatment Co., with the special problems of ion-Xchange. *To benefit from this leadership, call your IWT representative.*

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in complete condensate handling and boiler feeding systems

SCHAUB

stays with you from start to "phase-out"

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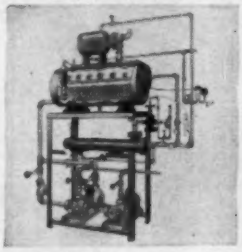

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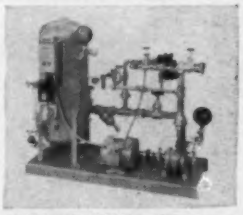
Guaranteed oxygen removal to .005/cc liter under 10-to-1 load swings, up to 250,000 lbs./hr. Other deaerators for smaller needs.



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Continuous steam and air removal eliminates steam traps and drainage device maintenance.

1. YOU STATE YOUR NEED—with no "ifs" or "buts".

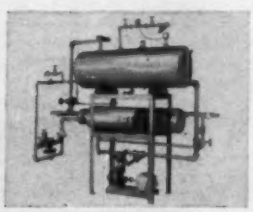
For instance, you may need a complete condensate handling and deaerating system, starting with outlying condensate return units discharging to a central surge tank. *Plus* transfer pumps with sequence controls to feed the deaerator itself. Finally boiler feed pumps and the controls to make the whole system work — with any degree of automation you require.

2. SCHAUB WILL ENGINEER AND DELIVER you such a system — or any part of it — and underwrite its continuous performance. All components are "phased-out" to work together as an integrated and balanced whole.

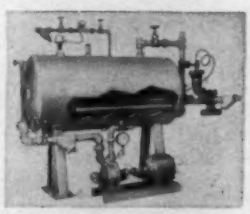
3. OR WE WILL SUPPLY you with individual packaged units — from pumps to console blowdown systems — to expand, augment or improve an existing system.

This is what we mean by Schaub "one-source" responsibility. From concept, through design to installation and service, you go best when you go Schaub — *all the way.* Hundreds of Schaub owners and engineers agree!

PACKAGED CONTINUOUS BLOWDOWN SYSTEMS
Automatic flash heat recovery, timer flush, sample cooling, drain after-cooling, high level shutdown, for any number of boilers.



HEAT RECLAIM SYSTEMS
Save about 10% on fuel with large percentage high pressure return systems.



PREE-HEET SYSTEMS
Stretch boiler capacities during peak loads while maintaining optimum pressures. Prolong life of boilers and return lines.

FACTORY-TRAINED REPRESENTATIVES COAST-TO-COAST. SPECIALIST ENGINEERS TO ADVISE, SUPERVISE INSTALLATION AND INSTRUCT IN MOST EFFICIENT OPERATION.

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because

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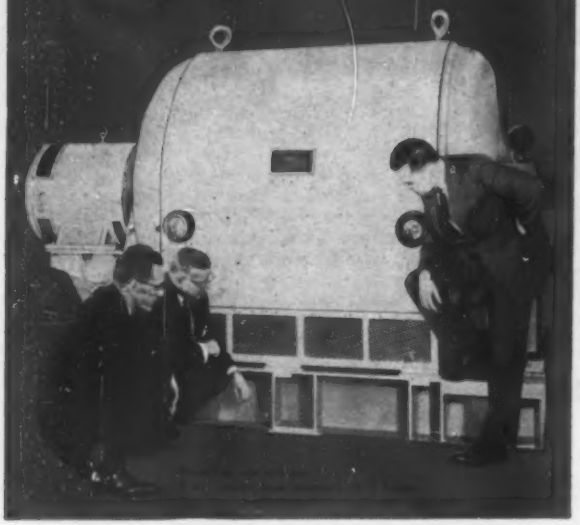

The Hackensack Water Company, Hackensack, New Jersey, like many users of IDEAL equipment, again selects IDEAL equipment on the basis of proven performance.

A new 2000 HP, 720 RPM synchronous motor with control shown at left, duplicates an Ideal unit that has been in operation since 1954.

There are good reasons why progressive commercial and municipal water suppliers—and others who require the utmost in performance and dependability — repeatedly choose Ideal equipment.

For complete details write for bulletin 501

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IDEAL ELECTRIC & MANUFACTURING CO.
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tubeaxial fans

high speed - high efficiency

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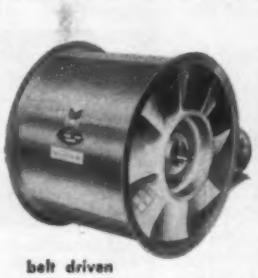
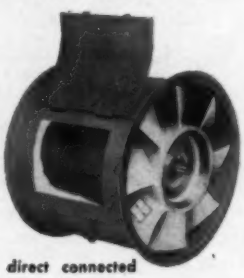


belt driven



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Aerovent FANS

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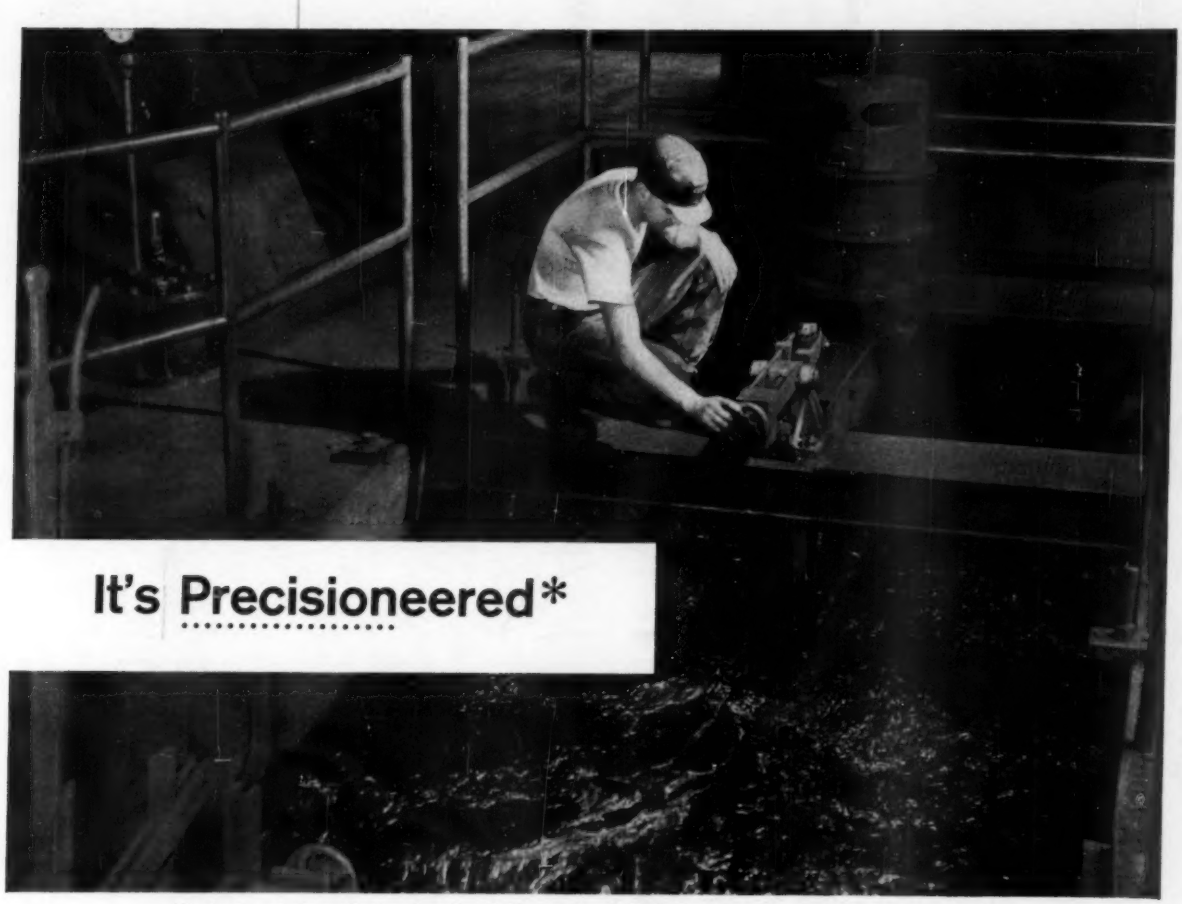

It's Precisioneered*

Washed coal stores better, handles better, and results in lower equipment maintenance costs.

* Everything that happens to a Precisioneered Coal at Island Creek is designed to make it do its job most efficiently, at the lowest possible cost. It starts at the mine face—with superior seams of eastern coal. It continues through the modern preparation plants where precision engineering techniques and strictest laboratory controls assure a product that will produce steam—in your equipment—at the lowest net cost per 1000 lbs. We'd welcome a chance to discuss the far-reaching engineering service and evaluation studies that are also part of Island Creek Precisioneering—and which can forecast in advance what can be done to lower net costs. Write. Or phone. No obligation, of course.

ISLAND CREEK
Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

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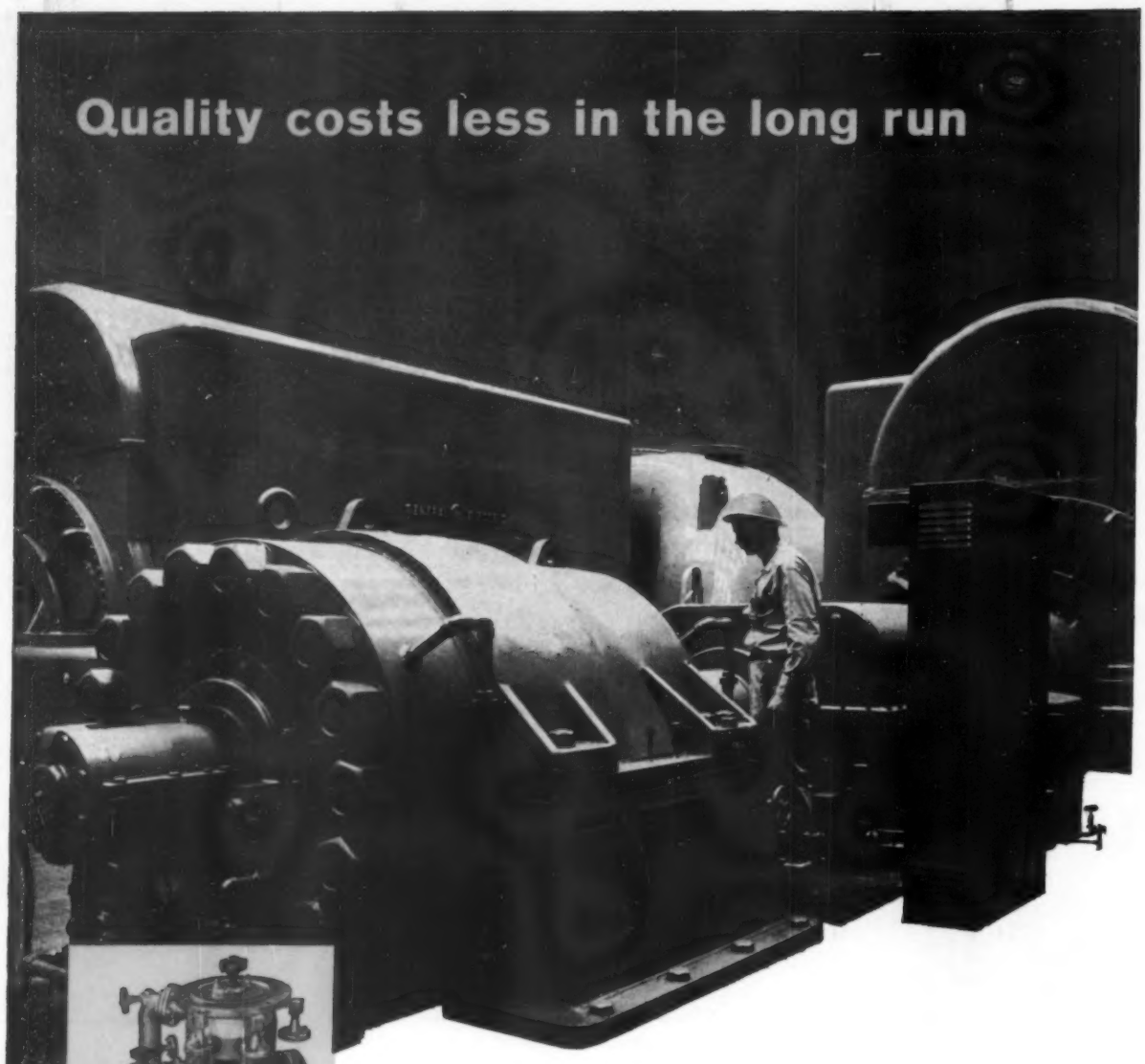
Quality costs less in the long run



"BLUE RIBBON" boiler feed pumps for every application . . .

Demands for higher pressures and capacities in modern boiler feed pumps have also created a need for higher speeds and greater reliability.

And in boiler feed pumps – as in every other type of centrifugal – Byron Jackson can match any requirement with a quality, performance-proved pump.

From direct turbine-generator driven models, such as the giant 12,000 horsepower, 3,600 rpm unit above, to the compact, 15,800 rpm marine boiler feed pump shown at the left, BJ designs are inherently reliable. Built-in balance, minimum NPSH requirements, and simple, effective sealing are common to all BJ Quality Pumps for the power industry.

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